SCIENCE

FRIDAY, DECEMBER 20, 1895.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Prof. J. McKeen Cattell, Garrison on Hudson, N. Y.
Subscriptions and advertisements should be sent to SCIENCE, 41 N. Queen St., Lancaster, Pa., or 41 East 49th St., New York.

THE LAW OF THE LONG RUN.

"MEN were surprised to hear that not only births, deaths and marriages, but the decisions of tribunals, the results of popular elections, the influence of punishments in checking crime, the comparative values of medical remedies, the probable limits of error in numerical results in every department of physical inquiry, the detection of causes, physical, social and moral, nay even the weight of evidence and the validity of logical argument, might come to be surveyed with the lynx-eyed scrutiny of a dispassionate analysis."

So wrote Sir John Herschel, a good many years ago, of the *Calculus of Probabilities*, which had just come into prominence through important practical applications. The 'Doctrine of Chance' is apparently miscalled because it is chiefly applied to the study and development of natural laws in the operation of which there can be no such thing as chance.

Popularly the word 'chance' is often used as if to imply the *absence* of any cause, but this is an unreasonable, if not an unthinkable condition. Really such words as 'chance,' 'accident' and the like imply only the absence of any assigned or recognized cause, and the doctrine of chances is a study and development of the laws relating to a series or aggregation of events, concerning the individual components of which we are absolutely ignorant. Thus, if

one tosses a coin, it is, in general, impossible to know in advance on which face it will rest. That its behavior in this respect will be governed by the operation of forces and conditions, just as certain and just as definitely compelling a given result as is the behavior of the sun and moon in the matter of an eclipse, will not be denied. If in any particular trial we knew all of the forces and conditions which influenced the result we should find that they were never equally balanced between the two possible events, but always predominated in favor of that which actually happened. A complete knowledge of antecedent causes would reveal the fact that each of these (to us at present unknown) forces and conditions is subject to other secondary influences which continually change its resultant effect from one side to the other, and so on, in lower degree, to the end *that in a very large number of trials* the ratio of the number of times the two possible events have occurred becomes very nearly one, to which, indeed, it approximates continuously as the number of trials increases. Note the use of the word *ratio* in this statement. In a very large number of trials in tossing a coin the number of heads may be always in excess of the tails and by a continually increasing amount, and yet the ratio of the two may be continually tending towards equality. It is important to call attention to the dependence of the Theory of Chances upon experience and experiment. It is not rigorously true, as is often stated in writing about probabilities, that if a coin is tossed in the air "it is as likely to fall upon one face as another." Such a condition necessitates an absolutely equal division of all forces and conditions between the two possible events, and it is logical to conclude that neither would happen. A more nearly correct statement would be that we are quite ignorant of any cause tending to one result rather than to another. As there are, apparently, but two possible results we may put the *a priori* probability of each at one-half. This conclusion is, however, of little value until experience has proved that in the case under consideration the controlling forces and conditions are so evenly distributed and nicely adjusted that the balance is easily thrown from one side to the other. If experience shows that in a certain series of trials there is a marked tendency for a coin to fall on one face rather than the other we are led at once to suspect that there is something in the manner of tossing, or in the nature of the coin itself, or in some other less easily understood condition, which has caused this tendency, and we know that our numerical expression for the probability cannot be correct. Experience, therefore, is essential to any useful application of this doctrine, and experience is valuable only when it is large. The numerical evaluation of a probability must be, at least, one which is not contradictory to experience and, whenever possible, it must be one supported and verified by experiment.

The above general remarks on the Doctrine of Chances (with apologies to the many who are quite familiar with the subject) are submitted with a desire to aid in clearing away some of the difficulties which many people encounter in trying to understand the usefulness of this most interesting branch of applied mathematics. In scientific investigation whenever our knowledge is so nearly complete and our mental vision so far reaching that we can trace the progress of the phenomenon under consideration, or of each of its elements from beginning to end, we do not need its aid. In the thousands of instances, however, in which primary causes are so obscure and so numerous that we can only know them by their integrated effects, its assistance has proved to be of incalculable value.

The object of the present article is to remind the reader that whenever the number

of these elementary controlling forces and conditions (generally quite unknown as such) is sufficiently large there will be a *definite integral*, which becomes more stable in form and character as the number from which it is derived increases, and that it may be depended upon and treated with as much confidence as if it were an observed and explained phenomenon. This is, of course, the basis of all statistical studies of natural phenomena. One or two simple illustrations may be given. In the case of tossing a coin it may be impossible to discover by any physical examination of the coin itself, or of the conditions influencing it when thrown in the air, any reason for the appearance of one face rather than the other. The *a priori* probability of the appearance of a given face may, therefore, be properly put at one-half. But in ten thousand trials there might be shown a tendency towards the appearance of heads, and if this persisted with an increase of the number of trials it would be legitimate to conclude that the coin was not uniform or symmetrical in structure or that the balance of forces and condition in tossing was not good. The universality of this principle has given rise to the idea of the *long run*, or, as it is sometimes put, the Law of the Long Run. In simple language this means that however obscure or relatively ineffective an influencing condition may be, *in the long run* it will make itself felt and may be evaluated in quantity and character if the number of examples is sufficiently great. It will be observed that this principle is different from, although not necessarily inconsistent with, the statement often made that minor departures from a general law, due to minute and continually varying influences, will, 'in the long run,' cancel and destroy each other.

It is not necessary to quote examples of the useful aplication of this principle of the long run in bringing to light hitherto unsuspected relations or unconsidered influences, but I may be allowed to refer to one simple and easily understood illustration, an account of which was published about ten years ago. It was founded on the following reasoning: An author with a generous vocabulary at his service must be continually making a choice among words that are nearly identical in meaning. The influences which control the choice are often numerous and doubtless generally unrecognized, but in the long run a certain set will prevail and the composition will be marked by this characteristic. It might not be impossible to discover the existence of each separate influence by an extensive analysis of the author's composition in such a manner as to reveal the characteristic of this influence to the exclusion of all others, but the labor of doing this would in many cases be enormous. In the paper referred to, the simple and easily reached characteristic dependent on the number of letters in the words used was proposed, and it was shown that when properly analyzed the composition of any author could be made to produce what was called a 'characteristic curve,' which, it was suggested, might prove to be peculiar to him and which might thus afford a clue to his identification. Some further applications of the suggested method have been made since the time of first publication which have tended strongly to confirm the view then held.

The application of the calculus of probabilities to the determination of life expectation and other quantities of great importance to life insurance and annuity companies has long been admitted, and statistical methods based on the principle of the long run have long been in vogue in the study of the distribution and prevalence of disease. There is good reason for believing that what is ordinarily known as purely accidental death and injury is governed in distribution by the same inexorable laws.

For illustrations of this proposition I am indebted to an officer of one of the great railway systems of the country, who has kindly furnished, during the past three or four years, most interesting statistical information relating to accidents, collected by him with the object of studying the results in the interests of the corporation with which he is connected. I have put the principal results in graphic form, but for those who like to see the numbers from which the diagrams were constructed I have included tables showing the classification of accidents, as to occupation, results, etc. Four years are included in this investigation, and there is shown in the tables and diagrams the average for the whole period.

on the track or other property of the corporation. The meaning of the diagrams will be readily seen, the circle, in each case, being divided into sectors proportional to the number of accidents in the several classes, the whole area representing the total in every instance, *regardless of the numerical magnitude of that total*, approximate constancy of *ratio* of distribution being the point under consideration. The persistency of this ratio is certainly very striking. Naturally the railway corporation collects this information with the view of being benefited by it, and therefore it may be expected that, as its character is developed from year to year, the operation of what has been called 'chance' in controlling the distribution of accidents will be

TABLE A.—CLASSIFIED AS TO OCCUPATION.

	NUMBER OF CASUALTIES.					RATIO OF DISTRIBUTION.				
	1891.	1892.	1893.	1894.	Mean.	1891.	1892.	1893.	1894.	Mean.
						%	%	%	%	%
Passengers	257	221	281	130	222	7.6	5.4	6.6	4.2	6.0
Travelers on public highway	190	239	179	195	201	5.6	5.9	4.6	6.3	5.6
Employés	2488	3105	3087	2339	2755	73.4	76.6	77.4	75.7	75.7
Trespassers	455	492	447	430	456	13.4	12.1	11.4	13.8	12.7
Total	3390	4057	3994	3094	3634					

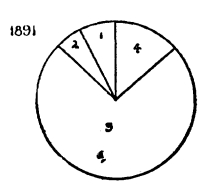


FIG. 1.

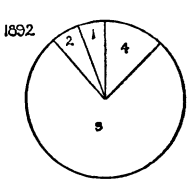


FIG. 2.

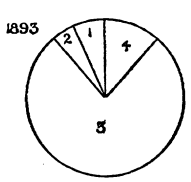


FIG. 3.

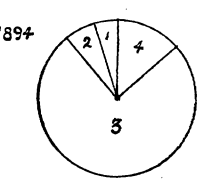


FIG. 4.

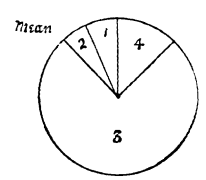


FIG. 5.

OCCUPATION.

1. Passengers. 2. Travelers on highway. 3. Employés. 4. Trespassers.

The first five diagrams show the distribution of accidents among the various occupations of the injured, at the time of the injury. The division is into the four general classes of passengers, employés, travelers on the public highways and trespassers

interfered with by new influences which will tend strongly to diminish the number of casualties, especially in those classes in which accident is most costly to the corporation. The results exhibited herewith furnish evidence that this influence is already felt.

It might be claimed that this constancy of ratio of distribution of casualties among the four classes is only a reflection of the constancy of the ratio of the numbers of those classes. It will be noted, however, that in the case of only two of them can anything be known of that ratio and, indeed, in these two only can it be anything like constant. Travelers on the public highway and trespassers can only come into the enumeration when they become victims of casualty.

An examination of the detailed figures as shown in Table A is instructive, as bearing on this question. Consider, for example, the two classes, impossible to enumerate in total, referred to above. The percentage of the total number of casualties affecting travelers on the highway does not vary greatly in the two years 1891 and 1892, being 5 % in 1891 and 5.9 % in 1892. The actual number of casualties, however, was 190 in 1891 and 239 in 1892, a variation of over 25 %. Is there any reason for assuming that more travelers on the highway were *exposed* to injury in 1892 than in 1891? In 1892 the number of persons injured was 700 greater than in 1891. If the method of investigation now begun be maintained for a sufficient length of time, causes for such variations in the total and in the distribution will undoubtedly be discovered. Whatever might have been the cause, in the present instance, of the increased number of casualties, it looks very much as if the increased vigilance exercised over the safety of passengers had shunted a part of the hazard over to the employés and travelers on the public highway, although there is no marked increase of percentage in either case. The matter might be put in this way: Seven hundred more people will be injured this year than last; employés and travelers on the highway will get a little more than their share of the increase, because the corporation is going to take a lit-

TABLE B.—CLASSIFIED AS TO NATURE OF INJURY.

	NUMBER OF CASUALTIES.					RATIO OF DISTRIBUTION.				
	1891.	1892.	1893.	1894.	Mean.	1891.	1892.	1893.	1894.	Mean.
						%	%	%	%	%
Death	348	366	341	266	330	10.3	9.0	8.5	8.6	9.1
Loss of limb	90	90	84	71	84	2.7	2.2	2.1	2.3	2.3
Loss of finger or toe	101	121	105	79	102	3.0	3.0	2.7	2.6	2.8
Spinal injury	15	51	105	21	48	.4	1.3	2.7	.6	1.3
Fracture or dislocation	225	269	268	194	239	6.6	6.6	6.6	6.2	6.5
Sprains	369	426	362	411	392	10.9	10.5	9.1	13.5	11.0
Cuts and bruises	1522	1913	1893	1134	1615	44.9	47.2	47.4	36.6	44.0
Miscellaneous	720	811	836	918	821	21.2	20.2	20.9	29.6	23.0

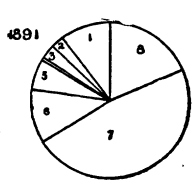


FIG. 6.

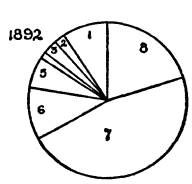


FIG. 7.

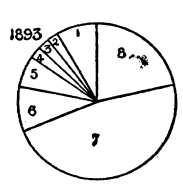


FIG. 8.

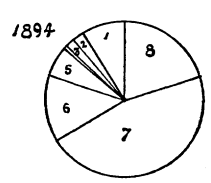


FIG. 9.

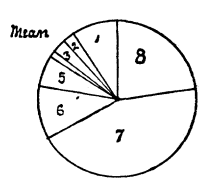


FIG. 10.

RESULTS.

1. Death.
2. Loss of limb.
3. Loss of finger or toe.
4. Spinal injury.
5. Fracture or dislocation.
6. Sprains.
7. Cuts and bruises.
8. Miscellaneous.

tle extra care of the passengers. The fourth class, the trespassers, seem, as usual, to have looked out for themselves and to have come out with a little less than their share of damage as shown by the previous year's experience.

The numbers for the year 1893 are interesting. This included a period of excessive passenger traffic, under conditions likely to considerably increase the total number of casualties. It was really, however, little different from and somewhat less than for the year 1892. Nor is the variation in ratio of distribution great, the several percentages agreeing well with the mean of the whole period.

But the most curious and interesting result brought out by the investigation is the constancy of ratio of distribution of *injuries among various classes*, such as death, loss of limb, loss of finger, fracture, etc. It is difficult to estimate the *a priori* probability of any one of these occurrences, and the facts here cited furnish a remarkable illustration of the operation of the principle or Law of the Long Run, as defined above. Indeed, in numbers relatively so small it is extremely surprising to find so many instances of persistency. General results as to character of injury and without reference to occupation are shown in diagrams 6, 7, 8, 9 and 10, and also numerically in Table B. We are here treating a total of about 15,000 casualties, an average of something less than 4,000 per annum. It would hardly have been expected in advance that during these four years there would be a nearly constant percentage of the total number of injured who would lose a limb, or that year after year almost exactly the same proportion would lose a finger or toe, or that the ratio of fractures and dislocations to the whole would be still more persistent, and this notwithstanding the fact that the total number of casualties would vary more than thirty per cent. Even when the analysis is carried much further there appears striking evidence of the same uniformity of distribution, although naturally there might be much less of it. In illustration of this I may cite the following: When the class of employés alone is considered and their injuries classified into the eight groups above referred to, in the two groups which contain the number of those who have suffered from loss of limb, or loss of finger or toe, injuries in which there is little chance of mistake in diagnosis, we find:

	Total Number.				Percentage of Total Number of Injuries.			
	1891	1892	1893	1894	1891	1892	1893	1894
Loss of limb..	34	35	34	26	1.4	1.1	1.1	1.2
Loss of finger or toe.....	89	110	94	74	3.2	3.4	3.4	3.3

Thus while the actual number of casualties varied considerably, the proportionate distribution remained extremely constant, particularly in the case of the loss of finger or toe. Although agreement in results where the numbers involved are not large must, itself, be regarded as fortuitous, it is interesting to note that in the class of trespassers, composed, it may be assumed, very largely of 'tramps,' of whom little regularity of any kind might be expected, and of whom about 450 are annually injured in one way or another, the ratio of loss of limb was in 1891, 10.8%; in 1892, 9.7%; in 1893, 9.4%, and in 1894, 9.8%. Of the same uncertain class, it is curious that in 1891, 8 suffered the loss of a finger or toe; in 1892, 9 suffered in the same way; in 1893, 8; but in 1894 this was reduced to 4.

Examples might be multiplied to almost any extent, but it is believed that enough has been shown to establish the existence, in this instance, of the principle under consideration. Indeed, so strong is the evi-

dence that we may feel quite justified in declaring that some error has crept into the classification of the injuries included in the three groups, sprains, cuts and bruises, and miscellaneous, as shown in the table for the year 1894. In short, it is more probable that error exists, either clerical, or arising from unusual professional carelessness in diagnosis, than that percentages of distribution, which have persisted so regularly during the three preceding years, should suddenly change to the extent shown in the table.

It is quite likely that the several accident insurance companies of the country have accumulated material relating to fortuitous events much more extensive than the above, which would yield equally interesting results if subjected to analysis.

There is one point to which it seems worth while to invite especial attention, namely, the confusion which often exists as to the inherent improbability of certain events. Such events are those which, for reasons entirely independent of the probability of their occurrence, have a particular interest. As an illustration, I may refer to the chance of the appearance of a particular hand at whist. Two or three years ago those interested in games with cards were greatly excited by the alleged occurrence of an event in the Boston & Albany railroad station in Boston. It was nothing less than that during the progress of a game of whist played by three railroad conductors and a mail agent, while waiting for the hour of departure of their trains, on taking up the cards after a deal each man found himself in possession of the whole thirteen cards of one suit. The *a priori* probability of such an event is all but infinitely small, and it was thought to be necessary to fortify the account published with affidavits of all the players and also of one or two gentlemen who happened to be watching the game. It probably occurred to few who read this account that the chances against any other particular distribution of the cards were just as great as against this, and that the result of every deal of the cards is just as remarkable as this and as little likely ever to occur again in the lifetime of the players. Indeed, any event of life, when considered in connection with contemporaneous and related events, in all their ramifications, will be found to have *a priori* chances so overwhelmingly against it that it seems impossible that it ever should happen. An 'accidental' death, for example, is an event generally unlikely, but in any specific case enough collateral circumstance and related fact can always be found to render the *a priori* probability of the combination nearly infinitely small. The chances of any man whom you may name meeting his death by falling from the third-story back window of the house belonging to his grandmother on his mother's side, and impaling himself on the point of a cotton umbrella accidentally left wide open in the garden below by the man servant of a gentleman named Witherspoon, temporarily stopping at the nearest inn, to whom he had loaned it on the day before at 2 P. M., in the lull of a thunderstorm which came from the north, are indefinitely small; yet I have been told that a man actually lost his life in just that way, and it is easy to see that the exact repetition of the simplest event in life, with all of its accompanying conditions and relations, would be just as incredible as this.

T. C. MENDENHALL.
WORCESTER POLYTECHNIC INSTITUTE.

HORTICULTURE AT CORNELL.

IN response to a request from the editor of SCIENCE, a brief outline of the purposes and methods of the work in horticulture at Cornell University is here given. This is the more willingly given because no full statement has been made of the capabilities

which the subject of plant cultivation offers as a means of education. Horticulture is ordinarily taught in a technical or professional way, as a direct training for the intending farmer or gardener; but the purpose at Cornell has been much different, and it may be said broader than this. The subject seems to be capable of adding much to the value of a course of liberal academic training. In the older fields of education such an outline as is here proposed might seem to be presumptuous, but in view of the novelty of the present subject and the awakening interest in it the sketch may perhaps be pardoned.

MATERIAL EQUIPMENT.

Before proceding to the more important aspects of the subject the reader may desire to know something of the facilities for the teaching of horticulture at Cornell. The material equipment is not large. It is exceeded in several other institutions in the country. If landscape gardening be added to the subject it must be said that the equipment and facilities in this theme are practically nothing. The horticultural department comprises two diverse yet cognate lines of effort, the teaching and the research. The latter is commonly known, now that the experiment station idea is widespread, as experiment work. The same lands and glass houses serve the two purposes. About ten acres of hilly and uneven land, upon which a miscellaneous but not large collection of fruits is growing, are allotted to the department. Something over an acre of this area is set aside for flower growing. The glass houses comprise eight structures, all connected, with an aggregate glass area of less than 9,000 square feet. These are plain, cheap structures, of which the total original cost, including heaters, was about $4,000. They are of the forcing-house type, and are adapted to the growing of the ordinary commercial crops, such as winter melons, cucumbers, tomatoes, lettuce, beans, carnations, chrysanthemums and the like. There are no museum collections, except a very valuable and rapidly growing herbarium of cultivated plants, in which there are now about 9,000 specimens. The small equipment is admirably supplemented in some directions by the orchards and gardens of the State, for it is the purpose to rely much upon the actual condition of horticulture in the Commonwealth as a basis of experiment and research. There are many experiments of importance which are now going forward on the farms of New York State; and whenever the investigation is of such a character that it can be conducted satisfactorily off the University premises it is in some respects better for the alienation, because it spreads the work before a larger constituency and ensures an accurate measure of its practical worth. But for teaching purposes these remarks will not apply.

THE MOTIVE OF INSTRUCTION.

The teaching of horticulture is of very recent origin. There are only two or three professorships of horticulture, uncombined with related subjects, in the whole country. The teaching of both agriculture and horticulture is commonly conceived of as a training for actual participation in these occupations. Most of the agricultural colleges are essentially training schools, at least so far as these subjects are concerned, and it is incontrovertible that they have exercised a powerful influence for the betterment of rural life. The Cornell teaching aims not so much to make farmers as to educate farmers' sons and daughters. In other words, its fundamental idea is to give those students who anticipate a rural life such a breadth of training as will put them into touch and sympathy with the traditions of education, with all the larger movements of the day, and which shall enable

them at the same time to understand the fundamental reasons of their own occupations. There is less attempt to apply the teaching upon the University farm than to instill a desire to master the underlying principles of agriculture. There is, therefore, no compulsory labor system any more than there is in the teaching of engineering or archæology. The student can ill afford the time while at college to perform mere manual labor. He must give all his strength to the acquirement of knowledge, and even then he finds four years all too short in which to grasp the essential principles of the complicated rural pursuits. Teaching is done by class exercises and by laboratory work, as it is in all other scientific and technical subjects at the present day. If the student hears a lecture upon the philosophy of the rotation of crops he also goes for a walk with the professor over the fields of the University farm and of adjoining lands and there observes the good and bad points of farm management. Or, if he hears a lecture upon winter tomatoes he also goes with the instructor, or alone, from day to day, and studies the tomatoes as they grow under glass. The sum of education as it applies to rural affairs is comprised in the two words, judgment and management; and the student needs to have his mind opened by thinking upon economics, language, history and general science quite as much as upon some of the particular subjects with which he is to deal in a more intimate way. The student should be a citizen before he is a farmer.

If the student once masters principles he is able of his own resources to apply them. Yet many mature students come to us—some of them graduates—who have been taught the applications, the methods of doing farm work, but who are greatly ignorant of the fundamental principles upon which these applications rest. From all these remarks it is apparent that much of the teaching does not lead directly, of itself, to better farm practice, but it aims to educate the student. Its effect upon the student is certainly salutary. As soon as he comes to learn that agricultural practice rests upon certain great laws, the operation and control of which are largely in his own hands, he becomes enthusiastic and develops a deep and abiding love for rural life. This result is not obtained by the mere training school.

HORTICULTURE AS A SCIENCE.

Speaking more specifically of horticulture, it may be said that the subject has merit as a science. A single illustration will suffice, without touching upon all the immediate science of cultivation and of vegetable physiology. The one greatest conception before the human mind at the present time is evolution. Data are demanded from every source. Upon the organic side, and within the realm of readily observable phenomena, the two greatest sources of facts in support of the hypothesis of evolution are paleontology and horticulture. My reader will no doubt at once accuse me of unseemly assurance in daring to associate horticulture with a science of such importance. Paleontology derives its chief interest from the fact that it spreads the broken pages of the old book of life before our eyes. Horticulture shows the movements in operation. Six thousand and more species of plants are widely cultivated, and most of them are broken up into many forms under the touch of the operator. Some species have produced thousands of distinct forms. These forms are recorded, and of many of them the exact methods and reasons of the genesis are known. A vast panorama of varieties, or 'incipient species,' as Darwin called them, is passing daily before us. Men talk of the probable influence of climate upon plants; the horticulturist can cite you definite cases by the

score showing influence of climate and in which there are no elements of conjecture. They speculate upon the transmission of acquired characters; the horticulturist knows that they may be transmitted, and he can furnish the proofs. Men want to know what may be the influence of selection, of struggle for life, of the change of soil or moisture or any other feature of environment; the horticulturist cites you to exact cases, before your very eyes, for these are the tools with which from the earliest time he has wrought and moulded the vegetable world at his will. You ask that a new species be created; the horticulturist has done it time and again, and he has the proof of botanical classification—which was made in ignorance of the origin of the given form or species—to show that the form really does rank as a good species; or if you will not accept the opinion of botanists or the testimony of your eyes, as to the real specific distinctness of the new form, the horticulturist will show you a hundred species of cultivated plants of which no one knows the original forms, because the present type is so unlike the original one that we have not yet been able to connect the one with the other. Twenty thousand new forms is a very conservative estimate of the number which the horticulturist has produced by changes in the conditions of life and by his efforts of selection. He, therefore, is of all men the one to talk about evolution, for he has his knowledge first-hand from nature. Paleontology is the Egyptian hieroglyphic; plant culture is the last revised edition of the record of the life process.

COURSES OF INSTRUCTION.

The courses of instruction now offered are twelve: The evolution of cultivated plants; the literature of horticulture; the botany of cultivated plants; the propagation of plants; pomology, or fruit raising; olericulture, or vegetable gardening; floriculture; greenhouse construction and management; the theory and practice of the spraying of plants; landscape gardening; instruction in handicraft; investigation for for advanced students.

Some of these courses are given as seminaries; that is, the students and instructor meet informally in a small room and discuss the subject of the day. Let us take the course upon the literature of horticulture as an illustration. There are no bibliographies of horticultural writings and no collections of books which intend to be complete. All this is proof that horticulture has had few students in this country. This course is the only one of its kind ever given, so far as we know. The University library has a fair collection of horticultural books, and the writer's collection of American horticultural literature is the most complete in its line. From these collections the course draws its supplies. The following subjects have been taken up for discussion so far this term:

The herbals; Roman literature; literature of landscape gardening; European grape literature; American grape literature; French literature; early American literature; German literature; current American literature; English literature; periodical literature.

The chief writings illustrating these various topics are taken to the seminary room, where they are freely discussed, the teacher acting more as a leader of the discussion than as an instructor.

Students frequently lead these discussions. This is particularly true of the seminary on greenhouses, now in progress. In this course the following subjects have been under review this term: Evolution of the greenhouse; side walls and foundations; roofs; interior arrangements; methods of heating; ventilation; styles of houses for particular purposes; glass and glazing; watering; pots and soils.

An important part of the teaching lies in the working out of special problems by the students. Some of the results of this work are worth publication, and a number of them have found record in the bulletins of the experiment station. Some topics now under consideration by horticultural students are these:

The influence of the mechanical texture of soils upon plants under glass; the evolution of the cultivated begonias; the relation of pollen bearing to the vigor of the plant; the relation of flower bearing to the vigor of the plant; the cultivated species of oxalis; the physics of greenhouse roofs; influence of crossing upon the resulting fruit; can acquired characters persist? the evolution of the current chrysanthemums; the philosophy of the watering of plants; the year's rewards in sweet peas; the viburnums as horticultural subjects.

The study of some of these subjects extends over a period of two or three years, and an effort is made to place all available material within the student's reach. The general plan of study is the monograph. In a study of the canna there were brought together nearly 300 varieties; of sweet peas, 120 varieties; of chrysanthemums, from 100 to 200 varieties. It is thus possible to arrive at a comprehensive judgment of the merits and evolution of the varieties, and the educational value of such work is great.

All this is work which demands a considerable maturity of judgment and much training on the part of the student. The reader will now want to know who these students are. In the first place, it should be said that they are few. This teaching is new and it has not yet secured for itself any recognition amongst the traditions of education. It is one of the most recent developments of the modern impulse which aims to carry the eductional method into every realm of thought and industry. It must be of slow growth; it must overcome much prejudice, and it must prove its right to exist. The roster of a single class, that in the evolution of cultivated plants and which is by no means the largest one, may satisfy the reader's curiosity. Fourteen students are at present taking the course. One is a professor of horticulture in a New England State institution and holds the degree of Master of Science; another holds the degree of Bachelor of Arts from the University of Michigan; another is a graduate of the Michigan Agricultural College; two are graduates of Cornell, one of them from the College of Mechanical Engineering and who has a love for rural life as well as for mechanical pursuits; one is the son of a leading Eastern seed merchant, who expects to enter his father's business; one has been a florist for fifteen years and has had training in two universities; two are Japanese; the others are special students who expect to follow rural occupations. Most of these men are fitting themselves for teachers or experimenters and have already reached years of maturity.

Aside from this class of students there are others direct from the farms who are crowding much special and technical work into a brief time. They find their places chiefly in the applied courses, as pomology, propagation of plants and the like, and at work in the gardens and forcing houses. They return to the farms when they have done with their college work. The total number of persons receiving instruction of the horticultural department during the year has been between sixty and seventy for the past two years. These are *bona fide* agricultural students, having come up to the University for the specific purpose of receiving instruction in the College of Agriculture.

EXTENSION TEACHING.

The teaching of agriculture is now indelibly associated with the distribution of the published results of research or experi-

ment work and with the giving of instruction before farmer's meetings. The itinerant teaching has been connected chiefly with the Farmers' Institute movement, which is now firmly established as a governmental enterprise in most of the Northern States. In New York, however, the movement has ripened into a custom of holding itinerant schools which shall be devoted to the particular interests of the locality in which they are held. Itinerant dairy schools have been held in this State, off and on, for a number of years. The first horticultural school of this type ever held was convened in Fredonia, Chautauqua County, New York, in the Christmas holidays of last year (1894). It extended over a period of four days. The underlying conception of the school was to give instruction in some of the fundamental principles of soil tillage and to awaken the enthusiasm of the participants. A system of observation teaching was introduced. A session was opened, for example, by putting leafless twigs into the hands of the students and requiring them to look at the specimens. It is needless to say that many original and novel observations were made, and that curiosity and enthusiasm reached a high pitch when some one stumbled on to the fact that the buds are arranged in geometrical order! These simple observation lessons have always been a source of delight to the participants in these classes, and they have probably resulted in quite as much ultimate good as the more didactic teaching. The students who enroll themselves in these schools are men and women of various ages, comprising persons who love rural life. The enrollment has run from 30 to 120 persons, but the teaching, having been given to the most intelligent persons in the community, exerts a very wide and abiding influence.

As a matter of contemporary interest and of history, the program of this first horticulture school is here inserted:

WEDNESDAY, DEC. 26, 1894.

2 P. M.

1. Announcements.
2. Observation upon *Twigs.*
3. *How Plants live and grow;* with demonstrations with the microscope: W. W. ROWLEE, Assistant Professor of Botany in Cornell University.

7 P. M.

4. *An Analysis of Landscapes;* with stereopticon views: L. H. BAILEY.

THURSDAY, DEC. 27.

9:30 A. M.

5. Observations upon *Fruit Buds.*
6. *The Nursery;* discussion upon the propagation of plants, illustrated with the operations and nursery-grown specimens: NELSON C. SMITH, Geneva.

2 P. M.

7. Observations upon *Seeds.*
8. *A Brief of the Evolution of Plants;* origination of varieties; philosophy of domestication and pruning: L. H. BAILEY.

7 P. M.

9. *The Geological History of Soils;* with stereopticon views: R. S. TARR, Assistant Professor of Dynamic Geology and Physical Geography in Cornell University.

FRIDAY, DEC. 28.

9.30 A. M.

10. Observation upon *Leaves.*
11. *Chemistry of the Grape and of Soils:* G. C. CALDWELL, Professor of Chemistry in Cornell University.

2 P. M.

12. Observation upon *Flowers.*
13. *Theory of Tillage and Productivity of Land:* I. P. ROBERTS, Director of the College of Agriculture, Cornell University.

7 P. M.

14. *What are Fungi?* Considered with special reference to the grape, with stereopticon views: E. G. LODEMAN, Instructor in Horticulture in Cornell University.

SATURDAY, DEC. 29.

9.30 A. M.

15. Observation upon *Fruits.*
16. *Commercial Grape Culture in Chautauqua County;* considered in various aspects: by S. S. CRISSEY, Fredonia; G. SCHOENFELD, Westfield; J. A. TENNANT, Ripley.

2 P. M.

17. Observation upon *The Apple.*
18. Continuation of No. 16.
19. General Question Box.
20. Final exercises.

"This is probably the first school of its kind devoted to horticulture in this country. With no pre-

cedents to guide us we shall probably make mistakes, but we shall all do our best. It will always be a pleasant memory that we have participated in a pioneer movement.

"The day exercises will aim at specific instruction in particular subjects. The evening exercises will be popular illustrated lectures.

"Everyone is invited to attend the various exercises. Persons have the privilege of enrolling themselves as students for the purpose of receiving personal aid upon the points under discussion. At the close of each day's exercise the students will be questioned upon the subjects. This questioning is not pursued for the purpose of ascertaining the student's knowledge of the exercise, but to elucidate the subject under discussion. During this exercise, also, the student has the privilege of freely asking questions upon the topic under consideration. It is expected that the instructors will not be interrupted with questions during the course of the exercise.

"Each day session will be opened with a *lesson upon observation*. Students will be given specimens, as indicated in the program, and ten minutes will be allowed for examination of them. The students will then be questioned as to what they have seen.

"Students should provide themselves with notebook and pencil.

"Roll will be called immediately upon the hour set for meeting.

"Printed synopses of all the day lectures will be distributed to students.

"While most of the instruction deals with fundamental principles, special applications will be made to the grape whenever possible."

About a dozen of these schools, of longer or shorter duration, have now been held. They always awaken a widespread influence. Frequently the residents of the village or city attend them in the interest of nature study. In Jamestown, a city of 20,000 people, the high school was dismissed upon one occasion to enable the teachers to attend an observation upon flowers. It is certain that these schools accomplish more direct good for the farming interests by means of this type of teaching than they could by simply specifying a set of rules which the farmer shall follow, or by giving up the time to so-called practical information. This teaching not only awakens the farmer himself, but it also interests all other citizens in his work. All this was never better illustrated than in a session at the Jamestown school devoted to insects. If one is to talk to a rural audience about insects it is presumed, of course, that he will devote himself to methods of destroying them. Not so here, however. Insects were passed around for observation, and *papier maché* models were in the hands of the instructor. The teacher soon had the audience interested in the insect itself. The students looked through the bug's eyes, heard as it heard, felt as it felt, and thereby came into sympathy with living things. For nearly two hours over one hundred people listened to this exposition in rapt attention, and it is safe to say that every student went away in a wholly new frame of mind respecting the objects which he had always been taught to dread.

EXPERIMENT OR RESEARCH WORK.

Aside from all this extension teaching, the experiment station publications must not be overlooked. Each State and Territory is in recent years issuing these periodical bulletins of instruction and information, and the effect is even now seen in the beginnings of an uplift in the agricultural population of which the outcome, at the end of the present generation, will be momentous and stupendous. Probably no government has ever inaugurated a movement which reflects more wisdom and statesmanship upon its promoters than this experiment station enterprise of the United States. It probes the very essence of national prosperity and lays a foundation of intelligence and inspiration which all the convulsions of time cannot overturn.

At Cornell the experiment station work has attempted to consider fundamental subjects, or those of abiding interest, rather than those of mere transient or local importance. Our horticultural inquiries have lain along three lines: the study of the

fruit interests of the State; the study of the forcing-house industry, particularly in relation to winter vegetables and the commercial flowers; studies in the systematic botany of cultivated plants. Many of the results have been published in bulletins of the experiment station. In the forcing industry we need soon to take up the growing of winter fruits, such as nectarines, peaches, cherries, grapes and the like, subjects for which we at present have no equipment. The influence of the electric light upon plants has been a subject of study for five consecutive years.

My reader now wants to know if the farmer appreciates it all. For New York State, I answer, Yes! A thousand times, Yes! Those who have kept no track of the farming population can have no appreciation of the almost volcanic awakening which is now taking place. Old methods are breaking down, old and cherished customs are crumbling, and in the confusion of the break-up and the transition the weak are going to the wall; but the best will survive! Rural life is the life of the future. Its inspiration and support are the irrevocable laws which are an inborn and integral part of the constitution of nature and of society.

The old and deserved derision of 'book-farming' is only a memory. Good teaching finds a response everywhere. In fact, the response is the measure of the teaching. The college professor is not only welcome, but is eagerly sought in almost every rural community. There is direct proof of this interest in New York State. The funds upon which we, at Cornell, are able to hold these schools and to make many investigations upon the farms were given by the State Legislature in response to a spontaneous demand from the people without any aid or abetting by teachers or experimenters.

UNSUPPLIED DEMANDS.

In purely horticultural directions the demands for better facilities of instruction are urgent. One of the chief of these demands is in floriculture and other glass-house industry. This is the refinement of rural industry, and it becomes prominent with the progress and refinement of the state. Floriculture is preëminently adapted to the employment of women, both upon the side of plant growing and upon the side of decoration and adornment. The value of the floricultural product in the last census year was over $26,000,000, and 2,000 women were then employed in the business. The enumeration of floriculture in the eleventh census, which was the first one ever made in this country, is said to have been suggested by Mrs. Porter, wife of the Superintendent of the Census, and originated in her desire to find employment for the many women who applied to her. All this great and growing floricultural and glass-house industry has no school which it may call its own, and none which is giving any specific attention to the subject. It is doubtful if any other industry of equal extent in the country is so completely without the means of education. The only way to become a florist now is to 'serve time' in an establishment. This the women, at least, can not do; but if there were a school where, in connection with good educational facilities, the art and practice and science of floriculture were taught, women as well as men could find an attractive outlet for their ambitions. The time cannot be far remote when some institution will honor itself with a school of floriculture.

In conclusion, the reader should be reminded that it is a fundamental concept of modern society that educational facilities shall be extended to every person. There must be a general intellectual uplift. Almost every profession and class of persons have been reached by this widening educational impulse, but the farmer and the horti-

culturist have been touched the least of all. These rural pursuits are particularly difficult to reach, not because the people who follow them are unwilling to learn, but be-because most of the instruction has been out of sympathy with them and unadapted to them. The more difficult the problem, the greater is the need of solving it. The rural industries must be enlightened by instruction which shall be both educational and useful. Nothing less can satisfy the demands of humanity and patriotism.

L. H. BAILEY.

---

*ON SCHOOL HYGIENE.**

HYGIENE is applied physiology. It is the science and art of promoting and preserving health, which we take to mean the greatest energy of each part, compatible with the greatest energy of the whole organism. School hygiene as an art is concerned with all measures that science and experience have shown to be helpful and efficacious for securing the normal growth and development of pupils and the normal activity of teachers, under the conditions incident to school life. Nearly one-quarter of the total population of the United States is at present subject to the conditions of school life, or, in other words, is engaged in the sedentary occupation of schooling. Of our school population over 96% is found in elementary schools, and over 18% is found in cities. Urban conditions at their best are less favorable than rural conditions for rearing full-grown, vigorous, healthy children. City-bred children of school age in America —at least in the six great cities on the Atlantic seaboard—are less favorably situated than their contemporaries in certain European cities, it would appear.

Thus the death rate per 1,000 living at the age-period 5–15, which is the healthiest decade of life among civilized men, is less in London than in Brooklyn, Philadelphia, New York, Washington and Baltimore, or in Boston, whose death rate is higher than in any of the cities named, while Berlin has a lower death rate than any of these cities, except Washington and Baltimore. The mortality from diphtheria among children of school age — and from consumption among female school teachers—is markedly greater in Boston than in any other of the American cities named above. No class of wage earners in Boston, so far as the mortality rates, analyzed by occupation, of the U. S. Census Bureau go, has so high a death rate from consumption as women school teachers, excepting marble and stone cutters. The fact that Boston is the only one these six cities which habitually neglects to wash her schoolhouse floors and corridors from year to year and decade to decade is not without significance.

It cannot be denied that municipal sanitation and school hygiene are more highly organized and successfully administered in the leading cities of Europe than in the leading cities of America. Indeed, school hygiene had no place or standing among the arts and sciences in America. There appears to be no department of public health so miserably endowed, so incompletely organized, or so wellnigh universally neglected by publicists, scientists and publishers as school hygiene. Without resorting to foreign books, periodicals and official reports, it is quite impossible for the student to inform himself as to the nature and results of the investigations and experiments made during recent years for the improvement of the health of the school population on the continent of Europe.

The public schools are organized, maintained and regulated by the State, which clearly owes it to itself to take adequate measures to prevent the school population

*Abstract of report of Chairman of Committee on School Hygiene—read before child-study section of National Education Association, at Denver meeting, July, 1895.

from contributing to the spread of epidemic diseases and thereby endangering the public health. It is also the duty of the State, particularly where attendance in school is compelled by law, to provide schoolhouses so placed, arranged and furnished that their occupants, both pupils and teachers, shall not be subjected to insanitary influences, or allowed to engage in unhygienic procedures in prosecuting their work. School boards as at present constituted, and teachers as at present trained for their profession, are unequal to organizing or administering a genuine and effectual system of school hygiene, such as the times demand in city schools. Experts in medicine, sanitation and hygiene are necessary, nay, indispensable for such a purpose.

If the public health is to be effectually guarded, the schools and those that frequent them should be subject to the inspection by properly trained representatives of the Board of Public Health, which board should have a voice in the selection of school sites, and in matters relating to the drainage, plumbing, heating, lighting and ventilation of schoolhouses. Ordinary physicians and teachers are not competent, as a rule, to pass intelligently upon questions of sanitary engineering which naturally arise in connection with the planning, erecting and furnishing of schoolhouses. Sanitarians, architects and hygienists should settle these and kindred questions. Even then there is room left for a special inspector or director of school hygiene, whose business it should be to see that teachers and janitors carry out such reasonable rules as may be laid down (with regard to the hygiene of the school, the class-room and the hygiene of the school child) by public health officers, sanitary experts and school officials acting together. The teachers should be made thoroughly conversant, during their professional training, with the hygiene of instruction and be required to conform to its principles in all practices and procedures which affect the eyes, ears, brains, muscles or bones of their pupils. These three classes of experts acting together could regulate the gymnastics and plays, hours of study, methods of instruction, in short, the school life of the children, in the interest of public health, personal hygiene and school efficiency.

The fact that no American university, medical school, technical school or normal school offers such theoretical and practical courses as are requisite for training up experts in school hygiene may be granted. But we submit that this state of things simply serves to emphasize the need of a campaign of education in the interests of hygiene in general and of school hygiene in particular. Let us strive to enlist the aid of physicians, sanitarians, educational authorities and philanthropists in planning and waging such a campaign. The ultimate aim of such a campaign would be the organization and maintenance of a comprehensive and effectual system of medical inspection and hygienic supervision of city schools and their pupils. To bring this about, the electorate must first be enlightened and aroused.

What can we do as members of the N. E. A. to further these ends?

1. We can utilize the literature of school hygiene in making known to the general and educational public the nature and results of European study and experiment.

2. We can urge the necessity of determining, by thoroughgoing investigation, the actual condition of the school population of our great cities, so that intelligent action may be taken to amend the most obnoxious and dangerous features of that condition.

3. We can endeavor to induce some progressive and influential university or technical school to grasp the idea that it would be performing a public service, and possibly enter upon a profitable speculation, if it

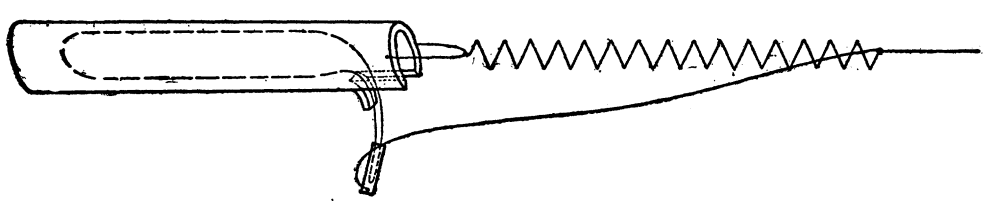
were to establish courses of instruction, similar to the best in Europe, for the training of experts in school sanitation and hygiene.

EDWARD M. HARTWELL.

BOSTON, MASS.

A SIMPLE APPARATUS FOR COLLECTING SAMPLES OF WATER AT VARIOUS DEPTHS.

VARIOUS devices have been used for collecting samples of water for bacteriological examination at different depths below the surface of a pond, but few of them are satisfactory. Some are too complicated and liable to get out of order; some are too expensive; some are too fragile for transportation; some cannot be well sterilized; while others have the besetting sin of operating at the wrong time or of failing to operate when required. Realizing the great importance of having a reliable method for collecting samples, the writer, after much experimenting, decided upon the form of apparatus here described.



It consists primarily of a glass tube $\frac{3}{4}$ inch in diameter and 5 inches long, closed at one end and having the other end drawn out at right angles and bent downwards as shown in the figure. The air is partially exhausted by means of an aspirator and the end of the tube sealed in the flame.

This vacuum tube is essentially the same as that first recommended by Pasteur, though he obtained his vacuum in a different way.

After being sterilized the tube is placed in the collecting frame, which consists of a piece of lead pipe about seven inches long and having an internal diameter of $\frac{7}{8}$ inch. At the upper end a strip of the lead is cut out and turned downwards, as shown in the figure, so as to form a rest for the bent arm of the glass tube. The glass tube is held in place either by a stopper pressed into the top of the tube or by a suitable spring clip passing around the bent arm and the projecting strip of lead. The weight of the lead is sufficient to sink the apparatus. A bail at the top of the lead pipe is attached to a spiral spring about eight inches long, which in turn is fastened to the cord or wire by which the apparatus is lowered. To the upper end of the spring there is attached a flexible wire, carrying at its lower end a small brass tube, one inch long, of such a diameter that it will easily fit over the end of the bent arm of the glass tube. The length of the flexible wire and the stiffness of the spring are so adjusted that when the apparatus is suspended by the cord in the water the flexible wire is slack; but when a sudden jerk is given to the cord the spring stretches so much that tension is brought on the flexible wire and a sudden pull communicated to the bent arm of the tube, resulting in the same being fractured. If the bent arm has previously been scratched with a file the break will be an even one.

The operation of collecting a sample is quite apparent. The glass tube being fastened in its place and the brass cap being put over the end of the bent arm, the apparatus is lowered to the required depth, care being taken that the cord runs out smoothly and without jerking. A sudden jerk is then given to the cord. This breaks

off the end of the bent arm, and the water rushes into the tube to an amount depending upon the completeness of the vacuum and the pressure of the water where the sample is taken. Usually the tube is found to be almost, but not entirely full.

After being drawn to the surface the vacuum tube containing the collected sample is removed from the frame and its end plugged with cotton or sealed with a bit of wax. Even if the end is left open there will probably be little danger of contamination on account of the shape of the tube and the small diameter of the bent arm.

The vacuum tubes may be conveniently transported in an ordinary 'cabin topped' leather bag, which has a tin box inside divided into two compartments, the lower one for ice and the upper one for the tubes which are placed in a suitable rack.

When a tube is to be opened a scratch is made near the bend of the tube with a file or glass cutter and the end knocked off, allowing the admission of a pipette. Both the glass cutter and the outside of the tube should first be sterilized by flaming. It is perhaps needless to say that the sample should be planted immediately after opening the tube.

This apparatus for collecting samples possesses several advantages. It is lowered and operated by a single cord. The whole apparatus may be easily sterilized by dry heat, or the vacuum tubes may be sterilized separately and inserted one after another in the collecting frame. The vacuum tubes are cheap and easily made; they may be transported without fear of breakage. There is practically no danger of contamination of the sample either in collecting, transporting or opening. The apparatus, if properly adjusted, is absolutely sure to operate at the right time and in the manner desired.

In conclusion, it may be said that the method has been used for some time at the biological laboratory of the Boston Water Works and its results have been uniformly satisfactory. A somewhat similar apparatus, in which a spring and flexible cord were used to open a small valve in the stopper of a bottle, was recently used by the writer at Lake Champlain to obtain samples at a depth of 370 feet. Even at that depth no trouble whatever was experienced.

George Chandler Whipple.
Newton Centre, Mass.

THE LOBACHÉVSKI PRIZE.

On May 1, 1895, the Lobachévski Fund had reached, beyond all expenses, 8,840 roubles, 95 kopeks.

This sum permits the accomplishment of the double aim of the committee: to found an international prize for research in geometry, especially non-Euclidean geometry, and to erect a bust of the celebrated scientist. The prize, 500 roubles, will be adjudged every three years to the best works or memoirs on geometry, especially non-Euclidean geometry.

The prize will be given for works printed in Russian, French, German, English, Italian or Latin, sent to the Physico-mathematical Society of Kazán by the authors, published during the six years which precede the adjudication of the prize. Works to compete must be sent to the Society at the latest one year before the day of award, October 22, old style (November 3).

The first prize will be adjudged October 22 (November 3), 1897.

To award the prize, the Society will form a commission to choose judges among Russian or foreign scientists.

The work of the judges (reporters) will be recompensed by medals of gold, bearing the name of Lobachévski.

As a fixed capital to found this prize, 6,000 roubles were invested.

Of the sum collected, an additional 2,000 roubles goes to share the expense of erect-

ing a bust of Lobachévski in the park bearing his name in front of the University edifice in Kazán, the remainder of the cost to be borne by the Municipal Council.

A special committee, consisting of representatives of the Municipal Council and of the Physico-Mathematical Society, has made a contract with Mlle. Dillon, who engages for 3,000 roubles to furnish a bronze bust of Lobachévski, to be placed on a granite pedestal, the height of the monument to exceed 3 mètres.

It is hoped to unveil the bust between the 15th and the 25th of September, 1896.

This 'fête mathématique' will follow the 'congrès des savants russes naturalistes et mathématiciens' at Kiev from 1st to 12th of September, 1896, and be during the grand Russian Exposition artistic and industrial at Nijny-Novgorod in the summer and autumn of 1896. Foreigners in any way identified with the name of Lobachévski are invited to the fête, and such as accept will be the guests of the city and University of Kazán.

For a second bust of Lobachévski to be placed in the Assembly Hall of the University, 200 roubles have been given from the Lobachévski fund, the remainder of the cost to be borne by the professors of the University.

The remainder of the sum already collected (640 r., 95 k.) will be added to the fixed capital. The augmentation of the capital will permit of a new edition of Lobachévski's works in a few years, the first volume of the Kazán edition having already become rare (out of print).

The Physico-mathematical Society of Kazán has already received a large number of works and memoirs relating to Lobachévski and non-Euclidean geometry, and now having added its own collection of the printed and manuscript works of Lobachévski, the Society has inaugurated a separate library under the name *Bibliotheca Lobachévskiana*.

It is hoped that in time this library will collect all the literature of non-Euclidean geometry and be an indispensable aid to those engaged in its development.

All writers on this fecund subject are begged to send to this library copies of their works.

Alas! That the Mathematico-physical Society of Hungary, a country having an equal claim to all the honors of the non-Euclidean geometry through the genius of Bolyai János, should have been content with placing in 1894 a monumental stone on his long neglected grave in Maros-Vásárhely!

GEORGE BRUCE HALSTED.
AUSTIN, TEXAS.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

THE sixteenth annual convention of the American Society of Mechanical Engineers was held December 3d to 6th, inclusive, in New York, at the house of the Society, No. 12 W. 31st St., the old home of the Academy of Music. The program included the presentation of 13 papers, mainly by members of the faculties of various schools of mechanical engineering, although the most notable papers were, perhaps, usually those of well-known practitioners. Many interesting and instructive 'topical discussions' took place also; and these usually brought out the most extended debates.

The papers of Messrs. McElroy and Webber were devoted to the discussion of the extent, availability and probable costs of power derivable from the Caratunk Falls on the Kennebec and the subject 'Water Power; its Generation and Transmission,' and were rich in valuable data and statistics of immediate use to the engineer and hydraulician. Mr. Emery gave a brief account of his work of rearranging the machinery and apparatus of a great oil refinery at Bayonne, by improving which he had saved already 32,000 tons of fuel *per annum*,

and is still effecting further gains. The methods adopted involved extensive utilization of exhaust steam and a limited application of electric power distribution. This was the most striking and suggestive paper of the week. The same writer discussed 'Comparative tests of Steam Boilers with different kinds of Coal;' showing that much uncertainty still exists in regard to the exact calorific value of the various elements of the fuels, and their mutual influence as burned in the fire-box of the steam boiler, and also in regard to the relation between the results of test in that manner and those obtained by the use of the various 'calorimeters,' bomb and other. The earlier work of Mr. Kent was the basis of the discussion largely.

Prof. Kingsbury's account of his experiments upon the friction of screws, by use of an ingenious and well-designed automatic apparatus of his own construction, interested the convention and gave rise to considerable discussion. Carrying pressures up to 10,000 and to 14,000 pounds on the square inch, he found coefficients ranging from three to twenty-five per cent., but showed that moderate values could be secured by the combination of proper metals in well-proportioned and accurately-formed journals and bearings. He proved that the heavy mineral oils, and especially those to which a small amount of graphite had been added, were best. With the latter a coefficient as low as three per cent. had been obtained. The testing apparatus was a modification of Prof. Thurston's oil-testing machine, in which the tremendous pressures on the square-threaded screws employed were carried in such manner as not to cause appreciable inaccuracy.

Prof. Goss described tests of the DeLaval Steam-Turbine, giving the horse-power hour on about fifty pounds of steam, a figure far above that usually claimed for that class of machine, and three times as high as the reported best record. Prof. Bissell described an ingenious recording device for testing machines and Prof. Carpenter discussed Sibley College experiments on the effects of heat upon strength of iron and steel; effects which were stated, in the course of the discussion, to have been also shown in the course of the more extended experiments of German investigators.

Prof. Barr's paper on the proportions of high-speed engine summarized his work in comparison of the proportions adopted by the principal builders, and showed that their practice covered a wide range, but that the best grouped themselves about the mean rather closely. Constants were thus introduced into the rational formulas of strength of materials by the author of the paper, which were representative of the extremes of practice and of the mean, which latter are presumed to serve as a good guide in general practice. This paper attracted much attention as being a first step in the direction of reduction of the vagaries of ancient practice to a reasonable and economical basis. Its author announced that he had already commenced a similar analysis of current practice, in the proportioning of the 'low-speed' engine.

Many other papers and discussions, which cannot be here noticed, contributed greatly to the instruction and profit derived from the convention. All will appear in the next volume of the transactions. The attendance was large, about one fourth the total membership. The Society, organized in 1880, now numbers about 1750 members and includes substantially all of the leading members of the profession. A novel and important feature of the convention was the appointment, at the request of the Superintendent of Buildings, of a committee to coöperate with architects and representatives of the building trades in the revision and improvement of the building laws. The newly elected President is the

distinguished iron master, John Fritz, the builder and manager of the famous Bethlehem Iron Works.

CURRENT NOTES ON ANTHROPOLOGY (XV.).

THE PITHECANTHROPUS ERECTUS.

IN SCIENCE, January 11, 1895, I published the first notice, in this country, of Dr. Dubois' remarkable find, in Java, of a creature intermediate between man and the apes; adding that his monograph could not fail to excite wide attention. This was so decidedly the case, so many articles appeared for and against the accuracy of his statements and conclusions, that the Dutch government sent for him to come in person and bring all his specimens to the International Zoölogical Congress in Leyden, in October last. He punctually appeared, with a large number of mammalian bones from the formation in which the Pithecanthropus was found, and an additional tooth of the animal itself.

The geological experts present decided that the various bones indicated the oldest pleistocene or else the youngest pliocene. The anatomists expressed themselves about the skull, teeth and femur of the alleged 'missing link.' Professor Virchow, probably the most conservative, maintained that the bones were of an ape; but an ape generically distinct from any known; and if the skull and femur belonged to the same individual then it was an erect ape, walking like a man; but he would not acknowledge that it bridged the gap between the anthropus and the anthropoid.

Practically the same result was reached by the eminent French anatomist, Dr. Manouvrier. He studied the originals in the possession of Dr. Dubois; and he declares there can be no doubt that in them we see the remains of a creature intermediate between man and the ape, walking erect, with a cranium like that of the gibbons, but much larger than any existing gibbon.

The conclusion is indisputable that in the Pithecanthropus we have an animal higher than the highest ape and lower than the lowest man.

AFFINITIES OF THE CHACO LANGUAGES.

DR. S. A. LAFONE QUEVEDO, well known for his studies of the native tongues of the Argentine Republic, has lately published some of his results in a paper entitled 'Las Migraciones de los Indios en la America Meridional.' The theory he advocates briefly is that the Kechua, the Aymara, the Araucan, Cacan, Guaycuru and Guarani are fundamentally much less different than has been supposed; that, allowing for phonetic changes, and adventitious and local forms, they have so much underlying similarity that we should regard them as developments from a common, ancient speech. To support this opinion, he lays much stress on the words for water, river, rain, etc., and on the personal pronouns.

Much more evidence will have to be presented before this opinion will be accepted. It is in conflict with the views of nearly all previous scholars. On the other hand, all will welcome the special studies of the same writer on the Chaco dialects. He has in press an extended grammar of the Abipone, and is engaged on another of the Mbaya and a third of the Payaguá. He has reached the conviction that the Vilela and Lule are the only two non-Guaycuru languages in the Argentine Chaco. If this is so it simplifies amazingly the extremely complicated ethnography of that region.

D. G. BRINTON.

UNIVERSITY OF PENNSYLVANIA.

SCIENTIFIC NOTES AND NEWS.

ASTRONOMICAL.

MEASUREMENT of the photographic plates taken for the purpose of making an accurate catalogue of all the stars in the heavens has decidedly gone beyond the preliminary stage.

From the last number of the *Vierteljahrsschrift der Astronomischen Gesellschaft* we learn that during the year 1894, 46 plates, containing 11,750 stars, have been measured at the Potsdam Observatory. At Paris, where measurements have been going on for two years, the number of star positions obtained is as follows, according to the reports of M. Tisserand, Director of the Paris Observatory:

In 1893, 27,750 stars, from 72 plates.

In 1894, 32,898 stars, from 120 plates.

ONE of the most extensive least square solutions ever made has recently been published by Prof. Schur, of Göttingen. The heliometric triangulation of the stars in the cluster Præsepe gave rise to a series of 74 normal equations, involving 74 unknown quantities. The solution of this set of equations was effected by Prof. Schur in ten weeks, by means of the usual Gaussian method of elimination. Prof. Schur comes to the conclusion that no other method of elimination, such as the method by successive approximation, is to be compared to the Gaussian method, even though it might seem to promise a saving of labor in advance. Prof. Schur mentions as the longest least square solution he has been able to find in astronomical literature a geodetic adjustment made by Bæyer, in which a set of normal equations with 86 unknowns was successfully solved by the famous computer Dase in three months.

H. J.

BIBLIOGRAPHIES OF THE SCIENCES.

RECENT numbers of the *Revue Scientifique* (Nov. 9, 16 and 23) contain important articles in regard to action taken by the scientific congresses on bibliography. A recommendation adopted by the French Association, the Berne Physiological Congress and the Brussels Bibliographical Conference proposes that the most significant word in the title of a scientific paper be indicated by a line printed under it and extending the whole length of the word, and that subdivisions of the subject treated be indicated by words in the title with lines printed underneath one-half the length of the word.

The International Bibliographical Conference, held in Brussels during September, has established an *Office internationale de bibliographie* at Brussels, and has requested the Belgian government to take the initiative in securing the coöperation of other governments in the support of an international bureau. The conference recommended without hesitation a decimal system of classification, and after some discussion the adoption of the Dewey system in its present form. The Physiological Congress, however, decided that careful consideration would be necessary before a system of classification could be finally adopted, and a committee was appointed, with instructions to report at the next Congress, consisting of Profs. Bowditch, Foster, Kronecker, Mosso and Richet.

It is to be feared that underlining the significant words in a title will cause difficulties to authors, editors and printers. When a title is properly chosen all the leading words should be significant and are likely to be nearly equally so. If a decimal classification of the sciences could be agreed upon, the object desired could be secured by requesting the author to indicate after the title what he regards as the proper classification of his article.

THE ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

AT the Anniversary Meeting on November 30th, at Burlington House, the reports of the officers of the Society were presented and the following officers were elected for the ensuing year:

President, Sir Joseph Lister; Treasurer, Sir John Evans; Secretaries, Prof. Michael Foster, M. D., and Lord Rayleigh; Foreign Secretary, Dr. Edward Frankland; other members of the Council, Mr. William Crookes, Sir Joseph Fayrer, Mr. Lazarus Fletcher, Dr. W. H. Gaskell, Dr. W. Huggins, Lord Kelvin, Prof. Alexander B. W. Kennedy, Prof. Horace Lamb, Prof. E. R. Lankester, Prof. Charles Lapworth, Major P. A. MacMahon, R. A., Prof. J. H. Poynting, Prof. A. W. Rücker, Mr. Osbert Salvin, Prof. H. M. Ward and Admiral W. J. Lloyd Wharton.

The Copley Medal was awarded to Dr. Karl Weierstrass, distinguished for investigations in pure mathematics extending over a period of fifty years. A Royal Medal was awarded to Dr. John Murray for his editorship of the report

of the Challenger Expedition and for his own large contributions to the work of the expedition, and to the scientific papers embodied in the report. A Royal Medal was awarded to Prof. J. A. Ewing for his investigations on magnetic induction. The Davy Medal was conferred on Prof. William Ramsay for his work on argon and helium.

Lord Kelvin, who retires at his own request from the presidency after five years of service, delivered an admirable anniversary address, reviewing the scientific events of the preceding year in so far as they relate to the Royal Society. After paying tributes to the memory of Cayley, Neumann, Huxley and Pasteur, he described the progress that had been made in regard to cataloguing scientific papers, the centenary of the French Academy, and other matters. He concluded by describing in some detail the work of those on whom the medals were conferred.

PROGRAM FOR THE PHILADELPHIA MEETING OF THE AMERICAN SOCIETY OF NATURALISTS.

Thursday, December 26th, 2 P. M.

1. Reports of Committees.
2. Special Reports.
3. Recommendation of new members.
4. President's Address: 'The Formulation of the Natural Sciences.'

8 P. M.

Illustrated lecture at the hall of the Academy of Natural Sciences, corner of 19th and Race Streets, by Prof. W. B. Scott, of Princeton University, on 'The American Tertiary Lakes and their Mammalian Faunas.'

9 P. M.

Reception to all the Societies given by Prof. Horace Jayne, at his home on the southeast corner of 19th and Chestnut Streets.

Friday, December 27th, 9 A. M.

1. Election of new members.
2. Election of new officers for 1896.
3. Other business that may arise.

10 A. M.

Discussion. *Subject:* 'The Origin and Relations of the Floras and Faunas of the Antarctic and Adjacent Regions.'

Geology: PROF. ANGELO HEILPRIN, Philadelphia Academy Natural Sciences.

Paleontology: PROF. W. B. SCOTT, Princeton University.

2 P. M.

Botany: PROF. N. L. BRITTON, Columbia College.

Zoölogy. Invertebrata of the Land: PROF. A. S. PACKARD, Brown University.

Zoölogy, Vertebrata of the Land, Fishes, Batrachia and Reptiles: DR. T. N. GILL, Smithsonian Institution.

Zoölogy. Vetebrata of the Land, Birds and Mammalia: MR. J. A. ALLEN, American Museum Natural History, New York.

Zoölogy. Vertebrata of the Sea: DR. G. BROWN GOODE, U. S. National Museum.

The maximum time permitted to each speaker is 30 minutes. General discussion at the close.

7:30 P. M.

Annual Dinner of the Affiliated Societies at the Lafayette Hotel, northwest corner of Broad and Sansom Streets.

GENERAL.

THE *Journal of Experimental Medicine*, a periodical to appear at least four times a year, will be published at the beginning of the year by D. Appleton & Co. The journal, which is to be devoted to original investigations in physiology, pathology, bacteriology, pharmacology, physiological chemistry, hygiene and medicine, will be edited by Professor William H. Welch, of Johns Hopkins University, with a board of twelve associate editors, as follows: For physiology: H. P. Bowditch, Harvard University; R. H. Chittenden, Yale University; W. H. Howell, Johns Hopkins University. For pathology: J. George Adami, McGill University; W. T. Councilman, Harvard University; T. Mitchell Prudden, Columbia College. For pharmacology: John J. Abel, Johns Hopkins University; Arthur R. Cushny, University of Michigan; H. C. Wood, University of Pennsylvania. For medicine: R. H. Fitz, Harvard University; William Osler, Johns Hopkins University; William Pepper, University of Pensnylvania.

THE Third Annual Congress of Teachers of Chemistry will be held in the Kent Chemical Laboratory of the University of Chicago, on Monday, December 30, at 2:00 P. M., and on Tuesday, December 31, at 9:00 A. M. The following subjects will come up for discussion in the order named: (1) Report of committee (Messrs. Freer, Noyes and A. Smith) on reasons why the study of physics should precede that of chemistry in the high schools. (2) Report of committee (Messrs. Freer, Swan and Linebarger) on a detailed outline of study of chemistry for the secondary and high schools. (3) Which method—the lecture, or the text-book system—is, on the whole, the most advantageous to use in teaching chemistry in the colleges? (4) Mendelejeff's periodic law; its place and its function in an elementary (say one year's course) in chemistry? (5) To what extent should physical chemistry be introduced into a course in college general chemistry? There will be no set papers read and the discussion will be entirely informal. Every teacher of chemistry in a high school or a college will be welcome and is invited to be present, no special invitation being necessary.

THE *Astronomischen Gesellschaft* has decided, because of the expense connected therewith, no longer to maintain a library. The announcement is made that the Society does not desire to receive any publications in the future and that, with the completion of the 30th year of the *Vierteljahresschrift*, no exchanges with other scientific bodies will be continued.

DURING the winter of 1876–77, the cormorants of the Commander Islands, *Phlacrocorax pelagicus*, were almost exterminated by an epidemic, dying in such numbers that the beach was strewn with thousands of dead birds. They recovered from this and by 1882 were again abundant, although by no means as plentiful as before. Dr. Stejneger reports that the species has again suffered from the ravages of disease and the cormorants are now exceedingly rare where they formerly abounded.

THE U. S. Geological Survey, and its officers, were awarded several gold medals and as many diplomas at the Atlanta Exposition, for the instructive, interesting and admirably installed exhibits that it placed there. There is a grand prize and a gold medal for the exhibit of relief maps, etc., a medal and diploma for the Chief Chemist of the Survey, Prof. F. W. Clarke, in 'grateful recognition' of his services in the installation of various exhibits, and a grand prize and gold medal to Dr. D. T. Day, of the Survey staff, for a study and exhibit, made with the coöperation of the Exposition Company, of the mineral resources of the South.

A MARK of the high esteem in which the work of the Geological Survey is held abroad has just been received by the Director. The recent Exposition of Mining and Metallurgy, held at Santiago, Chili, awarded the Survey the first premium for the Geologic Atlas of the United States and a collection of its publications. The maps and reports referred to constituted virtually the whole exhibit of the Survey at Santiago.

A NEW Russian medical journal, *Ruschisches Archiv für Pathologie, Clinische Medezin und Bacteriologie*, will be published monthly after January next. It will be edited by Prof. W. W. Podevyssotzky, of Kieff.

THE Secretary of the Royal Malacological Society of Belgium, Prof. Hugo de Cort, 47 Rue Veydt, writes us that he wishes to arrange exchanges of Belgian for foreign shells.

THE eleventh annual meeting of the Indiana Academy of Sciences will be held in Indianapolis on Friday and Saturday, December 27th and 28th. The State has undertaken the publication of the proceedings of the Academy.

IT is expected that the Astronomical Observatory of the University of Berlin will be removed to Dahlem, to which suburb, as recently stated in this journal, it is proposed to remove the Botanical Garden.

SURGEON-MAJOR DOBSON, F. R. S., died on November 26th, at West Malling. He was the author of numerous original researches in Zoölogy and comparative Anatomy.

THE Argentine Medical Club of Buenos Ayres offers three prizes, the first of $300 for researches in bacteriology, to be presented before May 31, 1897. The prizes are offered to honor the memory of Pasteur.

IN spite of the anti-toxin treatment, the epidemic of diphtheria in London continues; the number of deaths during the week ending November 30th was 63, which is 24 more than the average for the previous ten years.

DR. DONALDSON SMITH, who left England in the Summer of 1893, with the object of exploring Lakes Budolph and Stephanie, has just reached Plymouth, England. Since February nothing had been heard of him, until a telegram from Aden, at the beginning of November, announced the success of the expedition, and the arrival of Dr. Smith at that place. Dr. Smith will read a paper before the Royal Geographical Society next month, and in January will return to America, where an account of his travels will be published.

THE late Professor Verneuil is succeeded in the Paris Academy of Sciences by M. Lannelongue (who received 36 votes, while M. Ollier received 22), and in the Paris Academy of Medicine by M. C. H. Monod.

THE new anatomical and physiological laboratories of the University of Glasgow were opened on November 18th.

The Lancet states that the Royal College of Physicians of Edinburgh has purchased, at a cost exceeding $35,000, property on which a laboratory will be erected.

SIR HENRY ACLAND was presented, on December 4th, with a testimonial to commemorate his services during the forty years for which he has held the office of Regius professorship of medicine in the University of Oxford. A bust will be placed in the University Museum and over $15,000 will be given to the Sarah Acland home for nurses.

WE announced last week the death of Henry Seebohm, one of the most eminent and best known of British ornithologists. Mr. Seebohm was an explorer as well as an ornithologist, and his delightful volumes '*Siberia in Asia*' and '*Siberia in Europe*' brought him a wide circle of readers. Among the best known of his bird books are '*A History of British Birds*' (3 vols.), '*Monograph of the Plovers, Snipes and Sandpipers*' and '*Birds of the Japanese Empire.*' Several of his works are richly illustrated by colored plates. Seebohm followed no leader, and his numerous writings are always vigorous, interesting and original. Personally he was genial and generous, and his death will be sadly felt on both sides of the Atlantic.

WE regret to record the death of the Rev. Timothy O. Paine, a well known Egyptian scholar, on December 6th; of Professor W. N. Popoff, lecturer on physiology in the University of Dorpat, and of Dr. G. Krabbe, of the University of Berlin, on November 3rd, at the age of 80 years.

LORD KELVIN in his anniversary address before the Royal Society described the steps that have been taken towards the publication of an index of scientific literature. Through a gift from Mr. Ludwig Mond, F. R. S., $10,000 is available for the expenses of cataloguing, and there are now twelve copyists engaged in the work. About 140,000 slips have been mounted and classified. Lord Kelvin referred to the International Institute of Bibliography established in Brussels, but says that this will not interfere with the International Conference to which invitations have been issued for July of next year.

IN view of the approaching quinquenial census to be taken in 1896 in both France and England, it is interesting to compare the population of the two countries. In 1801 France possessed a population more then eleven millions greater than Great Britain and Ireland, whereas in 1891 the excess of population in France was less than one-half million. It is probable that the population of the United Kingdom is now the greater. In the two years 1892 and 1893 the deaths outnumbered the births in France, whereas in the United Kingdom there were nearly a million more births than deaths.

EDUCATIONAL NOTES AND NEWS.

MISS HELEN CULVER signed papers on December 14th giving $1,000,000 to the University of Chicago to be used for the biological departments. This gift carries with it $1,000,000 conditionally pledged by Mr. John D. Rockfeller on November 2d. It is probable that a school of medicine will be established.

THE *Academische Revue* states that the University Extension Movement in connection with the University of Vienna is meeting with much success. The first courses now being given number twenty-four, and in the first week 1,916 auditors were registered. The largest attendance (350) is in the course in anatomy, offered by Prof. Zuckerkandl. Each course is composed of six lectures, and the fee for attendance on the course is only about 20 cents. A small appropriation (about $2,000) has been made by the government toward the expenses of the movement. Vienna is the first German University, with the possible exception of Berne, to inaugurate University Extension.

IN May of the present year the Universities of St. Petersburg, Moscow and Kieff replied to an inquiry from the Minister of Education unanimously favoring the establishment of laboratories of psychology in all of these universities. A committee of eight professors from the University of Kieff have petitioned for about $3,000 for the establishment of a laboratory of psychology, and a yearly appropriation of $300.

PROF. E. OTIS KENDALL, since 1855 professor in the University of Pennsylvania, has resigned his position of Flower professorship of astronomy, but remains the nominal head of the department of mathematics and honorary dean and vice-provost.

PRESIDENT HILL, of Rochester University, has consented to postpone until the first of January his resignation from the presidency. His action is due to an address adopted unanimously by members of the faculty, urging him to retain his position.

DR. HERBERT NICHOLS, formerly instructor in psychology in Harvard University, has been appointed lecturer in psychology in Johns Hopkins University.

CARLETON COLLEGE, Northfield, Minn., has received $8,000 bequeathed by James H. Carleton, among other charitable bequests which now take effect on the death of his sister.

A NEW University, entitled *Université Nouvelle*, with power to confer degrees in all faculties, has been established in Brussels under the control of socialistic leaders. Among the professors are the geographer Prof. Elisée Reclus and the jurist Prof. Enrico Ferri, both of whom were unable to hold positions in their own countries The opening address of the Rector Professor Janson urged that property should only be acquired by labor and that the State should be the only heir. Sixty students were matriculated at the opening of the University, the future of which will be followed with interest.

PROF. RUTH has been appointed professor of geodesy in the Technical High School of Prague and Dr. v Rudzki assistant professor of mathematics in the University of Krakau. Dr. Kempf and Dr. Wilsing, astronomers at Potsdam, and Dr. E. Buchner, a chemist of Kiel, have been appointed to professorships. Dr. C. von Twardowski, privatdocent in the University of Vienna, has been elected assistant professor in philosophy in the University of Lemberg.

CORRESPONDENCE AND DISCUSSION.

A LAST WORD ON ERECT VISION.

I SAY 'last word' because I hope it may be the last I shall say on this subject at present, fearing that I have already occupied too much space, and not in the sense of a final solution. In the latter sense the last word is never said on any scientific question, much less on this question which has been discussed for two centuries and will probably be for two centuries more. But I wish, if possible, to state clearly the question as it seems to me, so that I shall not be misunderstood.

I agree with Prof. Minot that erect vision is *acquired by experience.* Yes, but *not by individual* experience. For the individual it is undoubtedly an inherited capacity—an endowment. It is acquired by experience, true; but by experience along the whole line of the evolution of the animal kingdom, and especially of the eye; and more and more fixed in brain structure or mental structure; until finally it is thoroughly inherited as any other capacity. This is, it seems to me, proved by cases of operation for congenital blindness from double cataract in persons sufficiently old to have acquired definite ideas of position in space by means of other senses. I refer now to only one carefully observed case recorded in the *Revue Scientifique*, Vol. 50, p. 571, 1892. An intelligent child,

blind from birth by double congenital cataract, was operated on at the age of six years. After removal of the bandages she saw at once, and without learning by experience, all things in their proper positions. Perception of *direction and position* was immediate, but not so the perception of the *relative distance* of objects. The former is a primary gift of sight, the latter a judgment and must be acquired by experience.

In this controversy we have again repeated the three old views on this subject. 1. The *nativistic theory:* It is a direct endowment of the eye or the brain, and there an end. This is the usual popular view. 2. The *empiristic theory:* It is acquired by individual experience, as we acquire the proper manipulation of the glass slide under the microscope. This is Prof. Minot's view. 3. The *metaphysical theory:* It needs no explanation at all. There is no such thing as up and down for the soul. This last we put aside as not a scientific solution. As to the other two, they are completely reconciled and the question, it seems to me, solved, as so many other vexed questions are solved by evolution. It is acquired—yes, but not by individual experience. It is inherited—yes, but not without experience.

Now, as to the legitimacy of my own explanation. A similar acquisition of ideas of direction or position in space by ancestral experience inherited and fixed in structure has taken place in all the senses, but especially in senses of touch and sight. Is it not legitimate to reduce these or their physical concomitants to a common law? Prof. Cattell (SCIENCE for Nov. 15, p. 668) objects that the different sensations are wholly *disparate* and, therefore, they cannot be explained the one in terms of another. This is true of *sensations proper*, such as light, color, sound, contact, etc., but it is not true of *direction* and *position*. These are not sensations; they are not peculiar to one sense. These are ideas underlying all the senses, gradually grown up in the mind as the result of deliverances of all the senses. They are not disparate for different senses. These ideas of direction and position in space are indeed purely psychical, true; but ought we not, if possible, to reduce their physical concomitants to law? This is what I have attempted to do.

I do not, of course, hope to settle this question to the satisfaction of all. I only wish to show that my explanation is not illegitimate as Prof. Cattell thinks, nor unnecessary as Prof. Minot thinks.

In conclusion I confess I do not quite see the relevancy of Prof. Minot's parenthetic remark. I do not see in what way the turning back of the retinal fibres to end in the rods and cones in vertebrates—though not in invertebrates—can affect the question of reference back along the ray line.

JOSEPH LE CONTE.

BERKELEY, CAL., November 29th.

MOUNTAIN CLIMBERS AND THE PERCEPTION OF DISTANCE.

TO THE EDITOR OF SCIENCE: I do not know that the attention of psychologists has been sufficiently called to the experience of mountain climbers as bearing on the problem of the perception of distance. Both Sir Martin Conway in his recent book, 'The Alps From End to End,' and M. Bonvalot in his book, 'Across Thibet,' have some suggestive remarks of the same general tenor on this subject, but I will quote only those of M. Bonvalot, as they seem on the whole the most pertinent. Speaking of the highlands of Thibet, he says: "It is difficult to imagine how hard it is to find one's way among these highlands, where a man loses all sense of perspective, his eye wandering over immense spaces without seeing, at given distances, either trees, houses, human beings, animals, or edifices the height of which is known to him. It is by the incessant and unconscious comparison of such objects as these that he has learned to form an idea of distance. Here in the desert we have in a few weeks lost this sense of distance which we had gained by the experience of our lifetime. All that one sees is so alike; one hill is like another; according to the time of day a frozen pool either sparkles in the sun or disappears, so that one does not know whether it is large or small; a little bird fluttering its wings upon a clod of earth looks like a wild animal which has been lying down and is getting up; a crow flying away with its prey in the morning mist seems to be a gigantic condor carrying off a lamb in its claws, while at sunset this same crow, cleaning itself on the

summit of a rock, looks the size of a yak or a bear."

It is plain from this experience that M. Bonvalot happened upon a new spatial world of size and distance, which he had to learn by a method of local visual signs, just as in infancy he learned the space world of the nursery room. It would be interesting to inquire of such travelers the exact nature of the signs they used in constructing the new space world.

HIRAM M. STANLEY.

MR. SPENCER ON TACTUAL PERCEPTION AND 'NATURAL SELECTION.'

MR. SPENCER concludes his long discussion on 'Natural Selection' by a short note in the October number of the *Contemporary Review* in which he claims that he has received from Prof. Weismann no answer to the crucial question he asked in his original paper (*id*, Feb., 1893). Mr. Spencer writes:

"But the main question he has every time passed over in silence. To my repeated inquiry—*How are the various degrees of tactual discriminativeness possessed by different parts of the outer surface of the body to be explained by 'natural selection' or by 'pannuxia'?* he has not only given no answer, but he has made no attempt to give an answer. The obvious implication is that no answer can be found."

Now, as I have already attempted (*Mind*, Oct., 1893,) to prove that Mr. Spencer's arguments from tactual perception are futile, and as his reply (*Contemporary Review*, Dec., 1893,) shows that he is not likely to be influenced by such evidence as I am able to adduce, I do not return to the subject in the hope of convincing him. I may, however, be able to show others that the facts of tactual perception have no special bearing on the sufficiency or insufficiency of natural selection.

Mr. Spencer found that the sensation areas (the distance apart at which points on the skin can be distinguished) on the tips of the fingers of two blind boys were $\frac{1}{14}$ inch and of two compositors $\frac{1}{17}$ inch, whereas Weber gave $\frac{1}{12}$ inch as the normal size. Mr. Spencer concludes from this experiment that the structure of the peripheral nerves and their connections are altered by use, and that these modifications of structure are hereditary. The fact that the tip of the tongue is more sensitive than the tips of the fingers is said to be because the tongue is continually exploring the teeth, although no advantage is gained thereby; the nose is more sensitive than the top of the head because it is more often rubbed by the fingers, etc. Mr. Spencer says that as the sensitiveness of the tip of the tongue is less important to man than sensitiveness of the finger tips it is impossible that the greater sensitiveness of the tongue could have been developed by the survival of useful variations.

Now this argument is such that the only reason for replying to it is that it is advanced by Mr. Spencer, whose contributions to philosophy are on the whole so important, that his utterances on special matters carry weight that they often do not intrinsically possess.

The experiments and theories of Weber have long since been superseded. Many thousands of experiments on tactual discrimination by a score of investigators have been published, and of these Mr. Spencer is ignorant. It is well known that the tactual discrimination of the blind is likely to be greater than that of others, but this could not have been determined from an experiment such as Mr. Spencer made. Tactual discrimination decreases in five minutes' practice far more than the amount given by Mr. Spencer as the greater sensitiveness of the blind; but this does not mean that the anatomical structure of the peripheral nerves has been modified, and that this modification will be hereditary.

The distribution of tactual discrimination on the skin seems to be exactly what would be expected were 'natural selection' a sufficient or an insufficient account of organic evolution. The parts of the body in which sensitiveness is most useful, the finger-ends and the tongue, are in fact the most sensitive.

There are two adequate reasons why the tongue should be more sensitive than the fingers. In the first place the lower mammals use the tongue as an organ of touch, it being far more sensitive than their hoofs or paws; a horse will reject the smallest bit of gravel from its mess of oats. As sensitiveness of the tongue is extremely useful to man for mastication and speech it is natural that the delicacy early de-

veloped should have been maintained.* † In the second place accuracy of skin localization is always a function of the mobility of the part. Where anatomical structure varies within narrow limits the sensation areas are small. As the tongue is far more mobile (the mobility is highly useful) than the finger tips, it could more readily develop and retain tactual sensitiveness.

In all cases where the structure or function of an organ is useful to the individual it may be attributed to the survival of variations or the inherited effects of use, and it does not seem that tactual discrimination helps to decide the all-sufficiency or relative importance of one of these factors.

When Mr. Spencer says that the sensitiveness of the tongue has been developed by involuntary and useless rubbing over the teeth, he seems to betray a complete misapprehension of the facts of psychology. The skin becomes less, not more sensitive by continual rubbing of the clothes, the contact of air, blood and food does not develop the accuracy of local discrimination in the inner organs of the body, etc.

I scarcely know a worse argument than this of Mr. Spencer's: (1.) That the blind are shown to have greater tactual sensitiveness than the seeing. [This would not be proved by Mr. Spencer's experiment but was well known.] (2.) That in these cases the practice of the blind has developed new anatomical structures of the peripheral and central nervous system. [A greater increase in accuracy of local discrimination can be developed with five minutes' practice.] (3.) That the anatomical structure acquired by use is hereditary. [This begs the question at issue.] (4.) That the relative sensitiveness of the skin cannot be accounted for by the survival of useful variations. [It is amply accounted for.] (5.) That useless sensitiveness has been developed by continual stimulation. [This is nonsense.] J. MCKEEN CATTELL.

* It may be remembered that Mr. Spencer thinks that organs will not disappear through 'natural selection' when they become useless.

† The nose is also used as an organ of touch by the lower mammals, and naturally remains more sensitive than the top of the head.

BIBLIOGRAPHY OF NORTH AMERICAN PALEONTOLOGY.

ONE of Mr. Van Ingen's criticisms in a late number of SCIENCE, on the recently issued Bibliography of North American Paleontology, 1888–1892, suggest that one of the errors into which he has fallen might also apply to others, particularly authors in paleobotany whose names have been omitted and of which a number are given as not being listed. The paleobotanical papers were omitted intentionally for the reasan that they were already receiving attention for publication in the U. S. National Museum when the work on the Bibliography was commenced. This fact should have been perhaps emphasized in the preface. But that there is so large a number of omissions as is claimed cannot be for a moment believed until substantiated by facts. In case the latter are forthcoming it would save much trouble in looking them up. Several, at least, of the 'valuable' additions made by Mr. Van Ingen as appearing during the period, while they do bear an included date on the title pages, were not received until sometime afterward, as library records clearly show.

As to many of the titles not being given in 'full,' as it is claimed by Mr. Van Ingen to be promised in the preface, it need only be stated that if he had turned his naked eye to the Bibliography instead of his microscope, he would have found some 800 other titles not given 'in full,' in place of the half dozen cited as examples of 'wrong copying.' In a listing of the papers all articles and often unimportant adjectives were purposely omitted, for reasons obvious to everyone familiar with bibliographic matter. 'Full' is clearly used in contradistinction to the usage in the secondary references where abbreviation as great as possible is necessary.

The regret expressed by Mr. Van Ingen that the Bibliography was not printed on one side only is no doubt shared by many 'working paleontologists,' even though Uncle Sam could not anticipate the utility of printing so valuable a work in colors to suit each prospective peruser. The special defect mentioned is, however, readily overcome by transmitting 20 cents to the director of the U. S. Geological Survey for a second copy of the work, that the 'pasting on cards' may go on uninterruptedly.

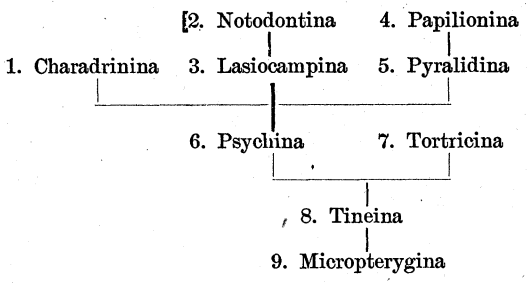
CHARLES R. KEYES.

SCIENTIFIC LITERATURE.

A Handbook of British Lepidoptera. By Edward Meyrick. London, Macmillan. 1895. 6,843 pp., 8°.

Within the compass of a very handy volume, in reasonably large type, Mr. Meyrick has contrived to pack the descriptions of over 2,000 British Lepidoptera, giving at the same time indications of their habitats, distribution, and time of flight, and, where known, a line or two descriptive of the larva, pupa and food plant; analytical keys are also added. It is not only precisely what its title implies, and so must be of distinct service to the young English entomologist, but it is a really new book and not a series of copied or condensed descriptions. It gives the beginner, however, no clue to anything beyond that to which he may go for fuller information, and the descriptions of the early stages are confessedly at second hand and unsatisfactory.

All this, however, hardly interests greatly the American entomologist, and if this were all there would scarcely be need of more than a brief notice in these columns. What gives the book a far wider interest is that the author has endeavored, by means of diagrams under about half of the groups, to express succinctly his views of the phylogeny of that group, and then has arranged the members in a serial order in accordance with their relative distance from what is regarded as the primitive type, the several members of each distinct branch, however, being kept together. Thus the Lepidoptera are divided into nine groups of families, as follows:



And they are then arranged in the book in the order indicated by the numerals which we have prefixed. "The order begins," declares the author, "with the most recently developed forms and descends gradually to the earliest or most ancestral, which are the last in the book." This brings the butterflies into the middle of the book, between the Lasiocampina and Pyralidina, a startling innovation, which will not fail to draw instant attention to the impossibility of arranging any large group naturally in a linear series.

It is evident that Mr. Meyrick has made use of the latest researches on the affinities of the different members of the Lepidoptera (which have been exceptionally important of late), and that he has also brought to the task he has undertaken much critical judgment; but it may well be doubted whether the Manual to appear in another thirty-six years (the time that has elapsed since Stainton covered the same ground) will not see as much change from the present work, especially through investigations on the early stages of these insects, as this work shows when compared with Stainton.

It were much to be wished that the author had used a rational nomenclature for the neuration of the imago, and not have employed the back-handed numerical method so much in vogue among Old World lepidopterists, a method absolutely without meaning and a mask of affinities. Many clear illustrations of the neuration accompany the descriptions, and the work is admirably printed and convenient at every point.

S. H. Scudder.

Atlas d'ostéologie, comprenant les articulations des os et les insertions musculaires. Par Ch. Debierre, Professor d'Anatomie à la Faculté de médecine de Lille. Paris, Félix Alcan. 1896. Pp. viii, 92. 253 gravures.

The superb anatomical atlases of Bougery and Jacob, and of Bonamy and Beau, have deservedly made French artists famous, and have been a mine from which anatomists of all countries have drawn for the illustration of their works. They are, however, so expensive as to be far beyond the reach of the ordinary student.

The present work has a totally different aim, being an attempt to present in a cheap and con-

venient form the principal topographical facts of human osteology. Its author is already favorably known by an excellent treatise on human anatomy, from which about one-half the illustrations of the atlas are taken. These again are many of them copied from older works.

A compilation made on this plan is necessarily somewhat lacking in artistic effect, and has not the unity that would be secured by a set of original drawings made by a single hand, and embodying a well conceived plan of instruction. There is no settled scale of representation, some of the bones being drawn full size, while others are not more than one-eighth of that and quite too small to show detail effectively. No statement of scale is made in any case, so that the learner is left in doubt as to the size of the object represented. Some of the illustrations appear unnecessary, while many important gaps occur.

For instance, the only example of internal bone architecture shown is a well-known figure of the head of the femur, and this, although said to be drawn from a photograph, is incorrect. The difficult sphenoid is very inadequately treated, its development, so important from a morphological point of view, being wholly omitted. In fact, there is no attempt to show the development of any of the cranial bones but the temporal, and that is not wholly satisfactory.

It is, of course, quite conceivable that Prof. Debierre should think proper to omit morphological subjects from an elementary work, but, why, in that case, should he give a scheme of a theoretical vertebra that will be wholly unintelligible to a beginner without adequate explanation, and devote three figures to Albrecht's rather doubtful theory of the constitution of the superior maxillary bone? Surely a figure might have been spared to show the difference between the primordial, or cartilaginous cranium and the secondary, or membranous one.

The merit of the book lies in its cheapness and availability. While by no means reaching the first rank, it will doubtless be useful to those who cannot purchase the expensive treatises of Testut and Poirier, and in convenience will far exceed those admirable works.

FRANK BAKER.

Catalogue of the Marine Mollusks of Japan, with Descriptions of New Species, and Notes on Others Collected by Frederick Stearns. By HENRY A. PILSBRY. Detroit, F. Stearns. 1895. viii+196. Pp.,8°. XI Pl.

This work has grown out of the collections made by Mr. Stearns, personally or by deputy, 1889–92, in Japanese waters, and which were submitted for identification to Mr. H. A. Pilsbry. It consists of three portions: a list of marine mollusks which have been stated to inhabit Japan, from Yezo to Kiushiu, with references to description or figures of most species, and an enumeration of the special localities at which each species has been found by previous naturalists or by Mr. Stearns. This is followed by a catalogue of the Inland Mollusks taken by Mr. Stearns in Japan, and, finally, by a list of mollusks obtained by that gentleman from the Loo Choo Islands. The work is concluded by an index of genera and sub-genera, and explanations of the eleven very excellent plates. Forty species and eight varieties believed to be new are described. The total number of Japanese marine mollusks, excluding those from the Loo Choo Islands, is about 2400, of which 36 are Cephalopods, 17 Pteropods, 1700 Gastropods and 650 Pelecypods. This is a fauna, nearly twice as great as that of the entire east coast of North America, a comparison which gives a vivid idea of the richness in molluscan life exhibited by the Japanese waters. It is probable that the discrepancy is still greater than these figures would indicate, since the dredge has been much more generally used on the American coast, and there are probably many species yet to be discovered even in the shallow waters of Japan.

The literature of Japanese mollusks is a good deal scattered, in spite of the magnificent publications by Lischke, Dunker, Schrenck and von Martens. This is illustrated by the fact that this work enumerates about five hundred more marine mollusks than the latest monograph by Dunker. Students are, therefore, greatly indebted, both to Mr. Stearns for the liberality which made it possible and to the careful work of Mr. Pilsbry, who has brought together the data for the comprehensive catalogue under review. The printing of the text and the execution of the plates are all that could be desired. Beside

mollusks, thirty species of brachiopods are enumerated, the richest recent brachiopod fauna known, and it may be added that Mr. J. E. Ives has given an account of the Echinoderms, Crustacea and Pycnogonida collected by Mr. Stearns, in the Proceedings of the Academy of Natural Sciences, Philadelphia, for 1891.

W. H. Dall.

ACADEMIES AND SOCIETIES.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

The members of the New York Section of the American Chemical Society dined at Morrello's, on 29th street, on the evening of the 6th inst., and from there adjourned to the College of the City of New York, 23d street and Lexington avenue, for the regular monthly meeting. This meeting was held in the lecture room of Dr. Doremus, to which the Society had been invited by that well-known chemist, and Dr. Webb, the president of the institution.

The meeting was called to order by Prof. P. T. Austen, and after the reading of the minutes of the last meeting, Dr. C. A. Doremus welcomed the Section to its new quarters, and recounted a brief history of the room and the adjoining laboratories, which are now the oldest rooms in the city devoted to chemical research and instruction. Dr. Wolcott Gibbs, now of Newport, and formerly of Harvard College, was one of the earlier instructors and investigators working in this place.

On motion, the thanks of the Section were extended to Dr. Webb and Dr. R. Ogden Doremus for the courtesy and assistance extended in these comfortable and commodious quarters for the Section's work.

The first paper on the program was that of Dr. P. R. Moale, chemist to the New York and Boston Dyewood Company, entitled, 'A Brief History of Naphthalene.' This brief history proved to be an exhaustive statement of the progress of the development of naphthalene from its first separation by Garden in 1820 from the scale of the condensing vessels used in the distillation of coal tar, believing it to be camphor or something similar thereto, through the work of Faraday, begun in 1826, Reichenbach, in 1831, to the later work of Dumas, Liebig, Wohler, Stas, Mitscherlich and Laurent, De Saussure and others.

Passing from the history of the formation and occurrence of this body, the reader took up the composition of the compound, presenting results of analyses by the several noted authorities.

Opperman's result	$C^{20}H^{3}C^{2}H^{2}$
Liebig and Wöhler	$C^{20}H^{3}C^{3}H^{3}$
Berzelius	$C^{10}H^{4}$
Laurent	$C^{10}H^{4}$ or $C^{46}H^{16}$
Faraday	$C^{20}H^{3}$
Dumas	$C^{40}H^{16}$
Dumas and Stas	$C^{30}H^{16}$

The reader then took up the constitution of the compound. Beginning with the investigations of Kolbe and Marignac in this regard he discussed the results obtained by Berthelot, Ballo, Graebe, Liebermann, Arnheim, Wreden, Claus, Baeyer and Perkin, Fittig and Erdmann, Bamberger; and from which it has been shown that the formula established by Graebe is that which must at present be accepted as nearest the truth.

In the discussion which followed, of the theoretical constitution of naphthalene, Mr. H. S. Neiman was called upon, and gave his experience in attempting the synthetic preparation of naphthalene for the purpose of throwing light on its constitution. He stated that the decomposition of certain amido-naphthal-sulpho-acids having a tendency to show that the position of the double bonds in the naphthalene ring are not symmetrical, attempts were made to disprove this by the synthetic production from ortho-xylene-tetra-bromide and ethane. By passing ethane over a heated mixture of granulated pumice stone and ortho-xylene-tetra-bromide, a portion of naphthalene was formed, but circumstances prevented further investigation. This formation would seem to show that the central bond is a double one, and the formula a symmetrical one as far as the bonds are concerned.

The second paper on the programme, that of Dr. T. B. Osborne, of the Agricultural Experiment Station at New Haven, Conn., on 'Vegetable Proteids,' is an exhaustive resumé of the classic work of the author upon these interesting and really little known bodies. He reviewed first the earlier investigations of these compounds, particularly those of Einhof, Berzelius, Dumas and Cahours, Ritthausen, Weyl

and Liebig, setting forth the state of our knowledge of the subject at the time of taking up his own study of it, and showing the tendency of professional opinion to the effect that a very close relation exists between the proteids of seeds and those of the animal system. The results of Dr. Osborne's work show the fallacy, except in a general way, of this opinion, and set forth the reasons why it cannot be accepted.

He takes up the proteids of the seeds in systematic order, beginning with the most soluble, and discusses the pertones, proteoses, albumins, globulins, glutinoids, alkali-soluble proteids, and neucleo-albumin and nuclein. He separates these substances by means of solvents such as alcohol, strong and dilute, salt solutions, weak alkali solutions, and precipitating them from the solutions by various reagents, obtains them in forms in which they may be studied. The results he has secured in this way are of the highest interest and value to the history of this class of bodies.

The third and last paper on the program was that of Dr. J. H. Wainwright, of the United States Laboratory, in this city, on 'The Determination of Solid Fats in Artificial Mixtures of Vegetable and Animal Fats.' His method consists in subjecting the mixture to pressure at the ordinary temperature of the laboratory, about 70° F. Much lower or much higher temperatures he finds detrimental to accuracy, as at 60° considerable of the higher melting point constituents are retained, while at 80° F. and above much of the low melting point constituent is removed. The method was devised particularly for the separation of compound lards containing cotton-seed oil, lard and stearine, with the special object of determining the percentage of oleo-stearine, which, in the presence of lard, could not be satisfactorily done by the ordinary methods where the information was obtained from the iodine number and other constants. Results were obtainable by this method within 1 per cent., but at present, until further investigated, the author allowed 1½ per cent. either way, or a total error limit of 3 per cent. in reporting results.

The General Secretary called attention to the time and place of the next and twelfth general meeting of the Society, which will take place on the 30th and 31st of this month at Cleveland, Ohio, and at which an unusually interesting and valuable program will be presented.

The next meeting of the New York section will be on the 10th of January.

DURAND WOODMAN,
Secretary.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE regular meeting of the Society was held on Tuesday evening, December 3d.

Dr. Otis T. Mason read a paper on the 'Influence of Iron Upon Native American Arts,' of which the following is an abstract:

Aboriginally the manufacture of iron was unknown upon the American continent. The native races, after receiving it, treated it as stone and worked it cold; they have nowhere become skillful in the use of it.

The term 'native American arts,' in common parlance, is ambiguous, now signifying all that the aboriginal tribes do and all that is collected from them; at another time it is made to mean only that part of their activities which they had in pre-Columbian times; at still another time the term is restricted to what the peoples of the Western Hemisphere themselves originated.

To get at the last two, there must be carefully eliminated everything added and suggested by the intrusion of the Iron Age, and everything must be restored that was crowded out, and supplanted by iron and its productions.

This elimination can be intelligently made only by knowing intimately what each intruding people had to bring, and really did bring. The history of America demands a study of the Eastern Hemisphere, especially the folk element and the folk arts in it. One must just as thoroughly know the stocks from which the intruders came. By studying those who came, what they brought, those to whom they came, the knowledge of the added result will be gained. A fact usually entirely overlooked in this connection is this, that as early as 1505 Ovando solicited that no negro slaves be sent to Hispaniola, because they fled among the Indians, taught them bad customs and never could be captured. In 1517 the slave trade was authorized by Charles V, and during three hundred

years, down to the time when scientific studies of the aborigines began to be made, five or six millions of slaves had been imported, a number equal to the entire native population of both Americas.

In the first half century middle America and South America were Latinized. The Dutch, French and English had monopolized North America in its northern and eastern portions two centuries ago. The Russians for more than a hundred years have contaminated the native arts of the northwest. Nine hundred years ago the Scandinavians invaded Greenland and six hundred years ago they were absorbed or killed by the natives.

The earth, even, does not divide the old from the new. The insidious iron is in shell heaps, in mounds, in cemeteries, in huacas and in ancient works of art.

Since these things are indisputably so, it behooves the true ethnographer, the true archæologist, the true linguist, the true historian, to enter into a friendly coöperation to reconstruct the native activity.

There are some things in favor of the true science, in spite of fraud, insufficient data and false labeling. There is, no doubt, a home flavor, a harmonious agreement among all the works of a people and the environment. The iron arrow-head is always coupled with a shaft covered with color and cuttings of an older age. The very shape and application of the new will conform to the methods of the old, though that be not the easiest.

In these transitions the old will sometimes excel, sometimes fall far below the new. Wherein the use of iron was adopted native art improved, wherein it was not useful native arts declined. It is not true that all good things are old or that all old things are good.

The modern contaminated native art is not to be despised, but when correctly understood it not only reveals to us the old that was concealed in it, but it suggests to the thoughtful man many of the roads and methods by which accultivation may proceed.

Major J. W. Powell, President of the Society, read a paper on *cognition*.

George R. Stetson,
Recording Secretary.

GEOLOGICAL CONFERENCE OF HARVARD UNIVERSITY, NOVEMBER 26, 1895.

Some Causes of the Imperfection of the Geologic Record. By N. S. Shaler.

Our treatises on geology have as yet not given quite enough attention to the array of causes which have tended to bring out imperfections in the geological record. The ordinary accidents of erosion, metamorphism, and the deep covering of beds by subsequently deposited strata have been taken into account, but there are a number of considerations which do not as yet appear to have been fully discussed, without essaying anything like a full presentation of these neglected influences certain of them will here be presented.

First it is to be noted that the record which we seek to interpret is to a great extent made either by the mechanical history of strata or by the organic events which are recorded in them. Certain influences tend in general to bring these divisions of the record into marked contrast with each other. When the process of deposition goes on with great rapidity the result is naturally a section of great thickness, but one which is likely to be barren or of limited fossil contents. Such a set of deposits on account of its great depth is likely to withstand erosion in an effective way and may remain for ages as the record of a time that has left no other monuments; on the other hand, the deposits of the period in question which are of an organic character are likely to be relatively thin, and if they be composed of ordinary limestone are very much more exposed to the assaults of decay.

Wherever we have extensive deposits of calcitic limestones the beds are exposed not only to superficial erosion and the like work of cavern streams, but also to a solutional process which with considerable rapidity may remove the materials composing the beds for all the depths to which the surface waters penetrate. In central Kentucky the spring waters are annually removing from the rocks in the dissolved state nearly as much rock matter as is eroded by the superficial streams. The result of this processs will be in time to leave the numerous arenaceous layers which are generally unfossiliferous and to remove the limestone beds which contain the most important part of the record. In this way we may perhaps account for the

relative absence of limestones in the rocks of the pre-Cambrian deposits without trying to assume that those sections were formed under substantially azoic conditions.

The more important records of geological successions have been made on the sea floor which is near the shore. At the present time by far the richest field for the development of marine life is in this narrow belt. It is likely that in early times the proportion of deep-sea species was less than at present and that in the paleozoic horizons the deeper sea may have been comparatively lifeless. But this zone of the richest marine life is precisely the part of the sea floor which is most likely to be subjected to destructive actions. We now recognize that the continents are subjected to successive oscillations which bring this littoral district again and again through the mill of the surf in the alternating movements of elevation and subsidence. Thus the portion of the earth's surface which contains the most valuable part of the geological record is the most exposed to the influences which tend towards destruction.

T. A. JAGGAR, JR.,
Recording Secretary.

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

AT the meeting on November 22d, President Thomas Seddon in the chair, the following papers were read and discussed:

Mobile Point as the Deep Water Harbor of the Gulf of Mexico. By G. D. FITZHUGH, of Birmingham.

Alabama Barite, or Heavy Spar. By HENRY MCCALLEY, assistant State geologist, of Tuskaloosa.

Atabama's Resources for the Manufacture of Portland Cement. By DR. EUGENE A. SMITH, State Geologist, University.

The Value of the Raw Materials in Iron Making. By DR. WILLIAM B. PHILLIPS, of Birmingham.

The Pig Iron Market, Its Extent and How to Improve It. By JAMES BOWRON, of Birmingham.

Mr. T. H. Aldrich gave a short talk on his recent efforts in prospecting for gold in eastern Alabama, in the counties of Cleburne, Randolph and Tallapoosa.

On motion of T. H. Aldrich the following committee was appointed to arrange for the compiling of statistics on the mineral and iron industries in the State for the purpose of circulating the same monthly to the technical journals, commencing in 1896: Mr. Thomas Seddon, Dr. William B. Phillips and the Secretary.

Dr. William B. Phillips gave a short account of the progress in his experiments in concentration of Red Mountain iron ores.

EUGENE A. SMITH,
Secretary.

ACADEMY OF SCIENCE. ST. LOUIS, DECEMBER 2, 1895.

THE Academy held its regular meeting at the Academy rooms, with President Green in the chair and twenty-three members and visitors present.

Dr. H. C. Frankenfield presented a communication on 'Hot and cold Waves' and 'The Deficit in Rainfall During the Past Three Years.' He spoke of the hot waves being caused by low areas, appearing in the northwest and moving east and south, thus bringing about warm winds from the south, and disappearing on the development of high areas in the northwest.

One of the accompanying phenomena of hot waves was hot winds coming from the southwest, their cause being somewhat obscure. Dr. Frankenfield stated that as a rule they move in narrow belts, ranging from 100 feet to half a mile in width. No good cause can be assigned for this, save, probably, local topography. One of their characteristic phenomena is a tremulous motion of the atmosphere, similar to that caused by heated air from a furnace. Also sudden abnormal rises in temperature, one instance being cited of a rise of 7 degrees in ten minutes.

The origin of cold waves is likewise very much mooted. As a rule a low area is followed by a high one, bringing a cold wave with it, but this is not invariable, as the cold wave occasionally comes without the low area, and sometimes without the high.

One theory as to where the cold air comes from is that of the descent of this cooler air from the extreme upper regions; the other theory, that it is simply the cold air of the surface, made so by radiation. In general it may be stated

that a high area acts as a carrier to a cold wave. The most severe cold waves are those in which the low area extends in a long and narrow, trough-shaped depression from the northeast to the southwest.

Dr. Frankenfield regarded the question of drought purely as one of distribution. The rainfall might be normal during a year, yet there would be a severe drought at a certain season of the year, simply because the rainfall was unevenly distributed, being excessive in some months and deficient in others.

Its effect upon the corn crop was illustrated in the case of the present year, where there was a general deficiency of rainfall and yet sufficient precipitation in the late spring and early summer to insure the safety of the crop. Commencing in August, there was an abnormal deficiency, but this was too late to affect the crop.

Mr. Allerton S. Cushman gave an informal talk on the present state of our knowledge regarding Helium, showing that it has been definitely proved that Helium is not a simple elementary gas, but in all probability a composition of two or more elementary gases.

A. W. Douglas,
Recording Secretary.

SCIENTIFIC JOURNALS.

THE AMERICAN GEOLOGIST, DECEMBER.

The first article is by Prof. N. H. Winchell, and is devoted to the comparative taxonomy of the rocks of the Lake Superior region. This is the last in a series of ten papers under the heading 'Crucial Points in the Geology of the Lake Superior Region,' the object of which has been to review and criticise the Correlation Papers on 'Cambrian' and on 'Archean and Algonkian,' by Messrs. Walcott and Van Hise respectively. Aside from questions of nomenclature, in which, as noted in these columns before, Prof. Winchell differs from those authors, he emphasizes two fundamental differences between his classification and that proposed in the Correlation Papers. First, he maintains the *absence* of a great erosion interval between the upper sandstones of the Keweenawan and the horizontal sandstones (Upper Cambrian) of this region; and secondly, he separates from the Keweenawan certain igneous rocks, especially the gabbros, which have usually been included in that formation. The paper is accompanied by a table giving a comparison between the classification adopted by the author and that used by the United States Geological Survey.

Mr. Oscar H. Hershey discusses the history of the river valleys of the Ozark Plateau from Jurassic time to the present day. He recognizes several periods of depression and deposition and of elevation and erosion, and summarizes these periods as follows: 1, Jura-Cretaceous peneplain; 2, Teritary valleys; 3, Lafayette formation; 4, Quaternary valleys; 5, Columbia formation; 6, the present valleys.

Prof. F. W. Cragin, in a paper of nearly thirty pages, gives a careful account of the Belvidere (Comanche Cretaceous) beds of southern Kansas. The typical section noted is called the Elk-Otter section, and this is described in detail, and the fossils characterizing the different beds are listed. The paper includes a statement of the classification of the Comanche divisions and terranes as adopted by the author.

Under 'Correspondence' Prof. G. Frederick Wright presents the views of Dr. N. O. Holst on the continuity of the Glacial period as expressed in a recent paper by that author entitled 'Has there been more than one Ice age in Sweden?' The usual reviews of current geological literature, list of recent publications, and personal and scientific news are given; under the latter is a statement concerning the operations of the Geological Survey of New York during the year.

NEW BOOKS.

Lehrbuch der Botanik. Drs. Strasburger, Noll, Schenck and Schimper. Second edition revised. Jena, Gustav Fischer. 1895. Pp. vi + 556. M. 6.50.

Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere. Oscar Hertwig. Fifth edition revised. Jena, Gustav Fischer. 1895. xvi + 612. M. 11.50.

Geological Survey of New Jersey: Annual Report of the State Geologist for 1894. Trenton, The John L. Murphy Publishing Company, Printers. 1895. Pp. ix + 303.